THURSDAY, DECEMBER 11, 1919.

## PARASITIC AMŒBÆ AND DISEASE.

*The Amoebae Living in Man: A Zoological Monograph.* By Prof. Clifford Dobell. Pp. vii+155+v plates. (London: John Bale, Sons, and Danielsson, Ltd., 1919.) Price 7*s.* 6*d.* net.

THIS is a very valuable piece of work, bringing order and critical intelligence to bear in a field of study which, already touched by many observers, has immensely increased in activity and importance during the war. The common fresh-water Amœba, living freely in natural pools, has many relatives, some of which have been distinguished by definite characters of the nucleus, form of pseudopodia, cysts, and other characteristics as "good" species and even assigned to distinct genera. But there has been no careful cytological study of the various species, though here and there important observations have been made. When to these forms are added those living in the soil, in sea-water, and, lastly, those parasitic in other animals, we find that there is quite a large group of these "amœboid" organisms which have been recorded from this or that habitat by observers who were hurried by other work or insufficiently trained in cytological methods. As a consequence, without sound method or criticism, specific and even generic names have been given to "Amœbæ," parasitic or free-living, and misleading sketches of them have been published. A perplexing confusion of inaccurate statements obscures the whole subject.

A great source of inaccuracy and vague statement has been the interest excited among medical men by the parasitic species of Amœba-like organisms and their association with dysentery and possibly with other diseases. As a rule the medical observers have not been trained "protozoologists," or attentive to the laws of zoological nomenclature. It is creditable to them that in the midst of other important work they have done so much in directing attention to these parasites. But to give any serious value to a knowledge of the Amœbæ as a guide to the diagnosis and control of disease, it was absolutely necessary that a high standard of accuracy in observation and statement, correct nomenclature, and a severe criticism of the accumulated mass of loose statements published by incompetent though well-meaning writers, should be applied to this subject by a competent authority having not only special experience and understanding of systematic zoology, but also time and opportunity to ensure full examination by him of the organisms in question.

The Government was fortunate in being able to secure the services of Mr. Clifford Dobell, assistant professor of Protistology and Cytology in the Imperial College of Science, for this purpose. Prof. Dobell had before the war made for himself a distinguished name as an investigator of the structure and reproduction of such minute parasites as the Coccidia, the Bacteria, and, amongst others, of the Amœbæ parasitic in frogs. He had carried the discrimination of details in the structure and reproductive changes of the threads and granules of the cell-nucleus of such minute organisms beyond that attained by other microscopists. His careful and precise work was recognised by his scientific *confrères* as certain to lead to sound conclusions when applied with ample time and material to the problem of the relation of Amœbæ to disease in man, and especially to the question of the causation of dysentery (and other diseases) by one, or more than one, species of Amœba.

In 1915 the return to this country of large bodies of troops from the Eastern war area—many afflicted with dysentery—rendered it necessary to examine the stools of a very large number of patients in order to decide whether those returning from Gallipoli and Egypt were suffering, as was supposed (but shown to be erroneously so), from "amœbic dysentery." A large number of trained workers were required for this purpose. Their training was undertaken, at first, by Dr. C. M. Wenyon, but when his services were required elsewhere at the end of 1915, Prof. Dobell took charge of the work and for four years has devoted himself uninterruptedly to the practical study of the intestinal protozoa of man. A large part of his time has been occupied with the routine work of diagnosis, with teaching that routine to others, and with the investigation of methods of treating amœbic dysentery. But, as he says, he has had great opportunities for studying the human intestinal protozoa from the zoological point of view, and probably no zoologist has ever before had such an immense amount of this special material at his disposal.

As a result, in spite of the really formidable difficulties in interpreting the results of many other workers, Prof. Dobell is able to say that almost all his own doubts have disappeared, and he presents to other workers in this field in the present volume a very full and detailed account of the work of his predecessors and of his own work and conclusions—together with the story of his methods of microscopic observation—illustrated by five remarkably well-executed plates.

This book is not for the general reader, and not even for every zoologist. It is addressed to the protozoologist who has some familiarity with the later developments of cytology, and is either already engaged in such studies or qualifying for them. At the same time we may briefly direct attention to some of Prof. Dobell's conclusions which have general interest. For reasons fully set forth, he reduces the number of species of "Amœbæ" ascertained to be living in man to six, which he arranges in four genera, as follows:—

Genus I.—ENTAMŒBA, Cassagrandi and Barbagallo, 1895 (*nec* Endamœba, Leidy, 1879).

Species 1. *E. coli*, Grassi; 2. *E. histolytica*, Schaudinn; 3. *E. gingivalis*, Gros.

Genus II.—ENDOLIMAX, Kuenen and Swellengrebel, 1917.

Species 4. *E. nana*, Wenyon and O'Connor.

Genus III.—IODAMŒBA, *nov. gen.*

Species 5. *I. Bütschlii*, Prowazek.

Genus IV.—DIENTAMŒBA, Jepps and Dobell, 1918.

Species 6. *D. fragilis*, Jepps and Dobell.

Of these only *Entamoeba histolytica* is proved experimentally to be pathogenic; it causes dysentery and liver abscess. None of the other five are pathogenic. *E. coli* is proved experimentally to be harmless. It is held by Prof. Dobell, in agreement with recent investigators, such as Goodrich and Moseley, that *E. gingivalis*, common on the human gums, is innocuous and not a cause of pyorrhœa. He cites their observation of the occurrence of *E. gingivalis* in pus from the mouths of dogs and cats. *Endolimax nana* is a small but well-marked innocuous species common in the human bowel. *Iodamoeba Bütschlii* is a small and uncommon species which produces in its cysts a mass of glycogen, which gives the mahogany stain when treated with iodine. *Dientamoeba fragilis* is a very small form studied only in seven cases. It is typically "bi-nucleate."

*Entamoeba coli* is as large as *E. histolytica*, and the two have been persistently mistaken for one another and confused in name. Even when occurring together they have not been distinguished. Hence endless misapprehension and trouble have arisen as to which "Amœba" it is that is harmless and which that causes dysentery. Lösch, in 1875, gave the name *Amoeba coli* to what is now by common consent called *Entamoeba histolytica*. Grassi, in 1879, described as the *Amoeba coli* of Lösch, not what Lösch had so called, but the harmless form which to-day passes under that name. Schaudinn (1903) described what Lösch had named *Amoeba coli* under the name *Amoeba histolytica*. Schaudinn *ought* to have recognised what he described as being Lösch's *A. coli*, but he *failed* to do so. Hence *E. histolytica* is to-day the name in use for the dysentery-causing species, and *E. coli* is that applied (contrary to the original use of the name) to the harmless species. Prof. Dobell declines (and we think rightly) to reverse or interchange the two names again, as such a course would cause "endless confusion." The mere citation of this one example of the misunderstandings of former authorities will serve to suggest to the reader how great are the difficulties in regard to nomenclature and identification with which Prof. Dobell has successfully contended. All future workers in this line must be grateful to him for his laborious and judicious treatment of these questions, as well as for his new and accurate observations.

E. RAY LANKESTER.

## ASTRONOMICAL LECTURES AND ESSAYS.

(1) *The Adolfo Stahl Lectures in Astronomy. Delivered in San Francisco, California, in 1916–17 and 1917–18, under the Auspices of the Astronomical Society of the Pacific.* Pp. xiv + 257 + liv plates. (San Francisco: D. S. Richardson, 128 Lick Building, 35 Montgomery Street, 1919.) Price 2.75 dollars.

(2) *Planetary Rotation Periods and Group Ratio.* By F. A. Black. Pp. xii + 115. (Edinburgh and London: Gall and Inglis, n.d.) Price 3*s.* 6*d.*

(1) THE Astronomical Society of the Pacific is in several respects an interesting and fortunate body. As Dr. Aitken recalls in one of these lectures, it had its origin in the co-operation of amateur and professional observers of the eclipse of 1889, which crossed California and was the object of an expedition, the first of a splendidly organised series, from the Lick Observatory, then only recently established. The society is essentially an amateur association enjoying the cordial support of professional astronomers, and this means much, for in its province—a thousand miles long—is to be found the most notable part of the instrumental equipment of astronomy in the world, including the three largest reflectors, with an average aperture of nearly 80 in. It bestows the Bruce medal on conditions which make the award the seal of the highest professional approval on the work of the recipient. It grants the Donohoe medal to the discoverer of every unexpected comet. Its "Publications," without having the severity of a conventional learned journal, contain notes on results of the most recent work, and often give an intimate account of observatory life in circumstances of peculiar interest, especially welcome to those who have had personal experience of it.

It was quite in accordance with the aims and spirit of the society that an organised course of six popular lectures should be given in San Francisco by members of the Lick Observatory staff in the winter of 1916–17, and equally fitting, but no less welcome, that a generous benefactor should be found in Mr. Adolfo Stahl to defray the expenses; for the readiness of Californian citizens to help worthy astronomical projects of all kinds with financial support is unequalled elsewhere. And Mr. Stahl's liberality did not stop there; for when the success of the first course suggested a second series in the following winter, this time with the help of the Mount Wilson and the Berkeley staffs, Mr. Stahl again lent the same aid, and when it was very properly felt that the lectures, which had been printed in the "Publications," deserved to be published in collected book form, he undertook once more to guarantee the cost. The result is this handsome volume, beautifully illustrated and containing a dozen lectures, popular in the sense of being simply stated and dealing for the most part with modern aspects of astronomy, by competent authors.

The first two lectures, on the solar system and on comets, are by the director of the Lick Observatory. Surely the time is at hand for an advance in our knowledge of the physics of comets. Dr. Aitken, who has acted as editor of the volume, is responsible for three lectures—on solar eclipses, on the moon, and on recent results from stars and nebulæ. Dr. H. D. Curtis discourses on nebulæ and on some aspects of astronomical discovery. Four single lectures are by Dr. Crawford on epochs in astronomical history, by Dr. St. John on the sun, by Dr. Leuschner on motions in the solar system, dealing mainly with recent computing work at Berkeley, and by Mr. Seares on the brightness, colours, distribution, and motions of the stars. These last three are very useful summaries of current work. The final lecture, on the Mount Wilson 100-in. reflector, was delivered by Dr. Ritchey, but not reduced to writing, and, owing to the lecturer's preoccupation with war work, it has been necessary to substitute an account compiled from other sources.

The book deserved an index. The photograph of the Pleiades (plate xliv.) was not by *Sir* Isaac Roberts. Did space not forbid, one would be tempted to dispute some of Dr. Crawford's views of history. Both he and Dr. Leuschner disparage Kepler's achievements by calling them guesswork. If to be fertile in hypotheses and to submit them instantly to the test of comparison with good observations be guesswork, then a good part of the truest scientific method is guesswork. Of this part Kepler is the supreme and unrivalled example.

(2) A reviewer would be quite justified in declining to take Mr. Black's little book seriously. It is a dreary collection of petty calculations, made with 7-figure logarithms when 4-figure would have been ample and printed *in extenso*. As there is no clear and intelligible summary, it takes no little trouble to find out what is the precise object aimed at, or how successfully that object is attained. But the effect is to set up an empirical relation between the rotation periods of the planets and their masses and radii, which may be expressed by the formula (p. 56)

$$\frac{T_1}{T_2}=\left(\frac{R_2}{R_1}\right)^{\frac{1}{2}}\left(\frac{g_1}{g_2}\right)^{\frac{1}{3}}=\left(\frac{M_1}{M_2}\right)^{\frac{1}{3}}\left(\frac{R_2}{R_1}\right)^{\frac{7}{6}},$$

$g=M/R^2$ being the surface gravity; the corresponding suffix notation is not Mr. Black's. Now among the eight planets the rotation periods of four are practically unknown. Obviously, three assumed periods can be satisfied rigorously by a proper choice of the two exponents. Hence a consistent result for the Earth, Mars, and Jupiter, with a 20 per cent. error for Saturn, has nothing impressive about it. The author then goes on to complicate his formula further by introducing imaginary satellites skimming over the surface of imaginary planets, and the effect (p. 59) can be expressed in the form

$$\frac{T_1}{T_2}=\left(\frac{R_2}{R_1}\right)^{\frac{1}{2}}\left(\frac{M_1}{M_2}\right)^{\frac{1}{3}}\left(\frac{M_2R_1^3}{M_1R_2^3}\right)^{\frac{1}{15}}\left(\frac{M_1R_1^3}{M_2R_2^3}\right)^{\frac{1}{15}}=\left(\frac{M_1}{M_2}\right)^{\frac{1}{3}}\left(\frac{R_2}{R_1}\right)^{\frac{7}{6}}.$$

So the results are naturally the same. In fact, Mr. Black plays on himself a variant of the old game beginning "Think of a number" with a portentous elaboration which may amuse some readers. On p. 59 the Sun should be substituted for the first planet mentioned in the definitions of both M and *m*.

The foundation of a second essay rests on the approximate equality of the mass ratios

$$\frac{\text{Jupiter}}{\text{Mars}}=\frac{\text{Saturn}}{\text{Mercury}},\quad\frac{\text{Uranus}}{\text{Venus}}=\frac{\text{Neptune}}{\text{Earth}}.$$

Of course, the mass of Mercury is really unknown, but it is rather remarkable that Newcomb's masses for Uranus and Neptune only require an adjustment each within 2 per cent. to make the second relation exact. With this slender material the author again builds up elaborate arithmetical combinations and finds an evident delight in results which are nothing more than simple numerical verifications of the laws of proportion.

H. C. P.

## THE DOMINION OF MAN.

*The Outline of History: Being a Plain History of Life and Mankind.* By H. G. Wells. With the editorial help of Mr. Ernest Barker, Sir H. H. Johnston, Sir E. Ray Lankester, and Prof. Gilbert Murray. To be completed in about twenty fortnightly parts. Part i. Pp. 32. (London: George Newnes, Ltd.) Price 1*s.* 2*d.* net.

IN this first part of his "Outline of History" Mr. H. G. Wells has surpassed the old author who carried the Trojan war back to Leda's eggs, for he begins with our solar system as a nebula condensing into sun and planets, and our earth as a mass of glowing matter. He tells how, in the course of cooling, an ocean gathered on its surface, on the margin of which the first structureless organic matter at last appeared, from which, in the course of ages, the earth's living tenants were developed. He describes in graphic terms not a few characteristic members in their succession, some of which are well depicted by Mr. J. F. Horrabin. Once or twice a phrase occurs to which we may demur: for instance, the nautilus is not a genus of ammonite; volcanic eruptions are more often a consequence than a cause of mountain upheaval; and we doubt whether the changes between the Mesozoic and the Kainozoic were so "catastrophic" as he implies. But these are trifles, and we find, after a discussion of the estimates of geological time, a good sketch of natural selection and the changes of species. As these changes in life depend not only on alterations in the world's physical geography, but also on its climate, the causes of the latter are briefly explained.

Next, Mr. Wells, after sketching the strange living tenants of the earth in ages when no creature with a backbone existed in sea or on land, brings before his readers the strange aspects of the earlier vertebrates, such as Pareiosaurus, which, low down as it is among the reptiles, seems as if striving to be a mammal. This leads

to the "Age of Reptiles," which is illustrated by such huge forms as Brontosaurus and Diplodocus, Stegosaurus and Triceratops, which might be a first attempt at a Pachyderm, together with Megalosaurus, Tyrannosaurus, and Iguanodon, besides Plesiosaurus and Ichthyosaurus in the sea, with flying creatures like Pterodactyles and Archæopteryx, half bird, half lizard; and then dentigerous birds, which pass on to the Kainozoic, and end the present part of the work, which when completed will be a broad survey of the world throughout time.

Mr. Wells has undertaken a difficult task, and it is not too much to say that no other writer of the present day is so well equipped as he is to bring it to a successful completion. He possesses the rare combination of brilliant literary power with comprehensive and precise knowledge, and this distinctive quality makes his work one in which all intelligent readers will find profit and delight.

## OUR BOOKSHELF.

*Principles of Electric Spark Ignition in Internal-combustion Engines.* By J. D. Morgan. Pp. vii+88. (London: Crosby Lockwood and Son, 1920.) Price 8*s*. 6*d*. net.

In the eighty or so pages of this little book Mr. Morgan gives the result of certain experiments by others and himself to determine the nature of electric spark ignition in internal-combustion engines. A wide circle of readers will feel grateful to the author for providing in this convenient form an account of the more important work along these lines, and for the reference which he provides to the sources from which information in fuller detail may be obtained. Mr. Morgan puts them still further in his debt by the lucidity with which he writes, and his manifest endeavour—almost always successful—to ensure that, even in the more intricate parts of the subject, his phraseology shall be free from the ambiguity which is so often the despair of readers of technical books.

Mr. Morgan explains most ingeniously and simply his view of the double nature of the spark, its important "capacity" component and the less valuable "inductance" oscillation. Experiment so far has failed to show any effect on the resultant gaseous explosion, or on the upper and lower limits of richness at which explosion will occur, of change in the size, temperature, energy, or other feature of the spark. Any one individual spark seems to be as good as any other, provided that explosion is caused; but the apparatus must be unfailing in the succession of sparks which it is designed to provide.

The book is one which should be in the hands of all who are interested in the scientific side of the design of internal-combustion engines in their many forms. That further work along these lines will cause spark gaps to be less sensitive than they now are to short circuiting caused by the inevitable gradual loss of insulation is greatly to be hoped.

## LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### Gravitation and Light.

JUPITER ought just to show the Einstein deflection, for if it pass between two stars a couple of diameters of the planet apart, their temporary relative displacement will be a "third" of arc, the sixtieth of a second; and this could be measured with a heliometer.

OLIVER J. LODGE.

Mariemont, Edgbaston, December 6.

### The Deflection of Light during a Solar Eclipse.

PROF. ANDERSON suggested in NATURE of December 4 (p. 354) a possible source of systematic error in the determination of the deflection of light at an eclipse, owing to lateral refraction caused by a temperature-gradient in the shadow-cone in our atmosphere. Having carefully considered this suggestion, I feel convinced that the effects of any possible temperature-gradient would be small.

Taking the height of the atmosphere as 10 miles, the ray from a star 30′ from the sun's centre would traverse a distance of 150 yards in the direction perpendicular to the shadow-axis whilst passing through our atmosphere. Prof. Anderson estimates a temperature-drop of 1/18 of a degree as required to produce the observed deflection. Thus the lateral temperature-gradient must be 1° C. per 1½ miles. The shadow moves over the earth at about 30 miles a minute, so that for a stationary observer the fall of temperature would have to be at the rate of 20° a minute to produce the observed effect.

In the case of a single surface of discontinuity, considered for simplicity by Prof. Anderson, the displacement by lateral refraction is inversely proportional to the distance from the sun's centre; but this law does not apply in the actual case of a continuous temperature-gradient.

It seems possible that the effect might amount to as much as 1/20 of the Einstein deflection in some cases, and possibly the rather high value found at Sobral has been increased by this cause. At Principe there was no perceptible change of temperature during the eclipse, but the climatic conditions there are exceptional.

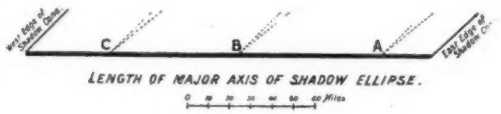
A. S. EDDINGTON.

Observatory, Cambridge.

PROF. ANDERSON'S letter in NATURE of December 4 raises a point well worthy of consideration—that is, the possibility of abnormal refraction due to the lowering of temperature in the air by the passage of the shadow cone. I do not, however, think that more than a very small portion of the effect noted at Sobral could be explained in this way. The shadow ellipse was 194 miles long (direction of motion) and 137 miles broad. I have drawn a section in the former direction to scale, taking the height as 20 miles. It is certainly unnecessary to take it higher, as the temperature of the upper air is unaffected by the passage of the shadow.

Photographs were taken at Sobral at uniform intervals throughout totality, and all give tolerably accordant values of the shift.

But at the point A, near the beginning of totality, the left-hand ray, coming from a star about 1° west of the sun, would be travelling from a denser to a rarer medium; the right-hand ray, coming from a star 1° east of the sun, from a rarer to a denser medium. Hence both rays would be deflected towards the east, and the distance between the stars would be unaffected. The same thing would happen at C, the deflection of both being now to the west. It is only at the middle point B that the apparent distance could be altered, and here the temperature-gradient vanishes.




Moreover, at A and C there would be no temperature gradient (and therefore no optical shift) in the plane perpendicular to the plane of the diagram. But the measures showed equal shifts in all directions. In actual fact, the presence of much cloud must have made the temperature gradients irregular; the fall of temperature at Sobral during totality was very small, doubtless owing to the cloudiness before totality.

A. C. D. CROMMELIN.

## Sex-Phenomena in the Common Limpet (*Patella vulgata*).

IN the course of investigations on the rate of growth and the age at which breeding begins the common limpet was examined, and the following interesting phenomena were observed:—A preliminary examination of batches of limpets of about 2 cm. long, and later still of smaller specimens, revealed the occurrence of a large proportion of males. The proportion of males was so high indeed as to give strong suspicions of a change of sex from male to female (*i.e.* protandric hermaphroditism), and a sample of about 1000 small ones less than 1 in. was therefore collected from cement piles between 3 ft. and 9 ft. above low-water springs at the Great Western Docks, Plymouth, and the sex examined and recorded. As the common limpet has no penis or uterus, it is necessary to examine the internal sex-organ (the gonad) to determine the sex. Of the 1102 limpets collected, 167 were rejected as being found by experience to be too small to show development of the internal sex-organ; these were mainly about 13 mm. long. Of the remainder, 169 (mostly about 14 mm.) showed no development of gonad on examination, 64 were females mostly about 2 cm. long, and the remaining 702 were males mostly about 15 mm. to 20 mm. long. These males probably comprise the bulk of the limpets in this sample in their first spawning year.

This result confirmed the suspicion that all limpets might be born as males, and to determine whether they all change into females a sample of about 600 larger but medium-sized specimens from 3 cm. to 4·5 cm. was examined from the same locality. Of these 255 were males, 3 of indeterminate sex, and 334 females. These figures indicated sex-change, but were not sufficiently definite; hence a further sample of about 1000 very large limpets, from 5 cm. to 7·5 cm. in length, was obtained from Looe Island and examined, with the result that 693 were found to be females, 18 were of indeterminate sex, and 301 were males. Some of these latter males were very big, ranging up to 6·5 cm. in length; some males, therefore, may live several years before changing into females, if, indeed, these larger males ever change into females. At the same time as these very large limpets were collected a batch of tiny limpets was taken from the same locality and the sex examined. Of this sample of 1233 tiny limpets, 138 were rejected as being too small (*i.e. circa* 13 mm. and less), and of the remainder, all of which were examined, 944 were males (mainly from 16 mm. to 20 mm.); 113 showed no gonad developed, and were mostly small, about 15 mm. in length; and the remainder, only 38, were females, and mostly about 2 cm. long.

Amongst the 102 females recorded in the 2030 young examined, however, 4 were found of a size about 15 mm. long. The writer thinks that this small proportion of small females will be found to be dwarf females analogous to those described by Conklin[1] and by Orton[2] in the slipper limpets (*Crepidula fornicata* and other species). In this investigation so far length of shell has been taken as an indicator of age, and doubtless *on the average* length is a good indicator for a given locality. But the rate of growth is known to be variable from as yet unpublished work, and it is surmised that the smallest female limpets are two-year-old forms in which growth has been stunted, and that such specimens are therefore older than their size indicates. In this case it would appear that sex-change may occur any time after the first spawning season. One ready method of testing this view would be to obtain a large number of young limpets of known age, and this letter is written mainly with the view of obtaining information of any dock-walls, slips,

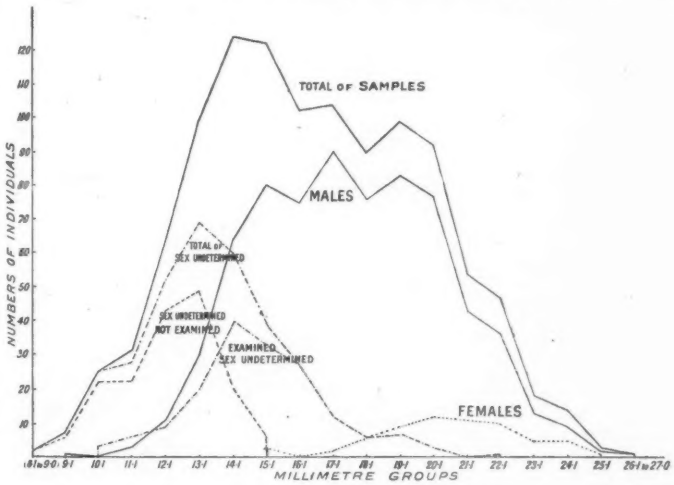



FIG. 1.—Length and sex analysis of a sample of 1102 young limpets under 1 in. in length collected at random at Plymouth, October 31, 1919.

1 "The Embryology of Crepidula." By E. G. Conklin. *Journal of Morphology*, vol. xiii., p. 12, 1897.

2 "On the Occurrence of Protandric Hermaphroditism in *Crepidula fornicata*." By J. H. Orton. Proc. Roy. Soc., B, vol. lxxxi., p. 480 1909.

or other constructions in tidal waters built during the years 1918, 1919, or even 1917. As the examination for sex can be conducted with speed only during the breeding season, which may shortly end in some localities, it is hoped that anyone knowing of suitable constructions will inform the writer at the address given below.

Evidence of sex-change is apparently already available from Gemmill's observations,[3] made so long ago as 1896. Gemmill found that 3 specimens out of 250 examined by him were hermaphrodite. In the samples quoted above no definite hermaphrodite forms were found, but several were suspected and preserved for microscopic examination. These forms were, however, mainly male or female, and are recorded above tentatively as males and females respectively. Sex-change may be seasonal, as is indeed indicated by Russell's observations on the sex of the common limpet.[4]

The sex-phenomena in the common limpet closely resemble in most respects those found in the slipper limpet, where the small females and large males are accounted for, but in which all the tiny ones—some thousands of which have now been examined—have a penis. It is, however, not impossible, on the evidence available at the moment, that sexual dimorphism without sex-change may explain the phenomena in the common limpet, but this explanation does not seem probable. The observations on the sex of the common limpet cannot all be described here; they will be continued and completed and the results published in the Journal of the Marine Biological Association, Plymouth. Fig. 1 shows a length-sex analysis of the sample of small limpets under 1 in. in length collected at Plymouth.

J. H. ORTON.

The Marine Biological Laboratory,
The Hoe, Plymouth.

### A Tribute from Prague.

PERMIT me to congratulate you upon the jubilee issue of November 6, which has just reached me and has been received with great pleasure, for the last number of NATURE which reached me before this was that of July 30, 1914!

It may interest readers of NATURE to learn that from that date the Austrian Government prohibited for more than four years the circulation of anything printed in England as a punishment for the regard which, especially during the war, we have always had for your country, to which, with the other Allies, we owe our liberty. To the bodily sufferings of the war was added isolation from nearly the whole civilised world.

In a year's time I shall celebrate the fortieth anniversary of my introduction to NATURE, for while a student of Owens College, Manchester, I purchased in October, 1880, my first copy of the journal, and since that time I have been an ardent reader, contributor, and even Bohemian correspondent. The reading of NATURE'S all-round scientific contents has been one of the greatest pleasures of my life in my leisure hours, and the richness of information which I have gathered from it cannot be expressed in better words than those of Dr. Deslandres in the jubilee number. I do not wonder that all attempts at founding a similar scientific and yet popular (in its best sense) journal in other European countries have invariably failed, for there a man of science is usually identical with a professor (a professional worker); and though I am one myself, yet I am of the opinion that the scientific character of NATURE is in no small measure due to the high type of British scientific amateur or student of science for its own sake, which I do not find equalled in any other country in the world.

Even we scientific workers in this remote part of Europe owe sincere thanks to Sir Norman Lockyer, who is a brilliant representative of the "non-professional" English man of science, for providing us with NATURE and conducting it so admirably for so many years.

BOHUSLAV BRAUNER.

Chemical Laboratory, Bohemian University,
Prague, November 17.

3 "On Some Cases of Hermaphroditism in the Limpet (Patella), with Observations regarding the Influence of Nutrition on Sex in the Limpet." By G. F. Gemmill. *Anat. Anzeiger*, xii., pp. 302–9, 1896.

4 "On the Shedding of the Limpet (*Patella vulgata*)." By E. S. Russell. Proc. Zool. Soc., 1909 (1), p. 226.

## *EINSTEIN'S RELATIVITY THEORY OF GRAVITATION.*[1]

### II.—THE NATURE OF THE THEORY.

IN the first article an attempt was made to show the roads which led to Einstein's adventure of thought. On the physical side briefly it was this. Newton associated gravitation definitely with mass. Electromagnetic theory showed that the mass of a body is not a definite and invariable quantity inherent in matter alone. The energy of light and heat certainly has inertia. Is it, then, also susceptible to gravitation, and, if so, exactly in what manner? The very precise experiments of Eötvös rather indicated that the mass of a body, as indicated by its inertia, is the same as that which is affected by gravitation.

Also, how must the expression of Newton's law of gravitation be modified to meet the new view of mass? How, also, must the electromagnetic theory and the related pre-war relativity be adapted to allow of the effect of gravitation? With the relaxation of the stipulation that the velocity of light shall be constant, will the principle of relativity become more general and acceptable to the philosophic doctrine of relativity, or will it, on the other hand, become completely impossible?

One point arises immediately. The out-and-out relativist will not admit an absolute measure of acceleration any more than of velocity. The effect, however, of an accelerated motion is to produce an apparent change in gravitation; the measure of gravitation at any place must therefore be a relative quantity depending upon the choice which the observer makes as to the way in which he will measure velocities and accelerations. This is one of Einstein's fundamental points. It has been customary in expositions of mechanics to distinguish between so-called "centrifugal force" and "gravitational force." The former is said to be fictitious, being simply a manifestation of the desire of a body to travel uniformly in a straight line. On the other hand, gravitation has been called a real force because associated with a cause external to the body on which it acts.

Einstein asks us to consider the result of supposing that the distinction is not essential. This was his so-called "principle of equivalence." It led at once to the idea of a ray of light being deviated as it passes through a field of gravitational force. An observer near the surface of the

1 The first article appeared in NATURE of December 4

earth notes objects falling away from him towards the earth. Ordinarily, he attributes this to the earth's attraction. If he falls with them, his sense of gravitation is lost. His watch ceases to press on the bottom of his pocket; his feet no longer press on his boots. To this falling observer there is no gravitation. If he had time to think or make observations of the propagation of light, according to the principle of equivalence he would now find nothing gravitational to disturb the rectilinear motion of light. In other words, a ray of light propagated horizontally would share in his vertical motion. To an observer not falling, and, therefore, cognisant of a gravitational field, the path of the ray would therefore be bending downward towards the earth.

The systematic working out of this idea requires, as has been remarked, considerable mathematics. All that can be attempted here is to give a faint indication of the line of attack, mainly by way of analogy.

It is no new discovery to speak of time as a fourth dimension. Every human mind has the power in some degree of looking upon a period of the history of the world as a whole. In doing this, little difference is made between intervals of time and intervals of space. The whole is laid out before him to comprehend in one glance. He can at the same time contemplate a succession of events in time, and the spatial relations of those events. He can, for instance, think simultaneously of the growth of the British Empire chronologically and territorially. He can, so to speak, draw a map, a four-dimensional map, incapable of being drawn on paper, but none the less a picture of a domain of events.

Let us pursue the map analogy in the familiar two-dimensional sense. Imagine that a map of some region of the globe is drawn on some material capable of extension and distortion without physical restriction save that of the preservation of its continuity. No matter what distortion takes place, a continuous line marking a sequence of places remains continuous, and the places remain in the same order along that line. The map ceases to be any good as a record of distance travelled, but it invariably records certain facts, as, for example, that a place called London is in a region called England, and that another place called Paris cannot be reached from London without crossing a region of water. But the common characteristic of maps of correctly recording the shape of any small area is lost.

The shortest path from any place on the earth's surface to any other place is along a great circle; on all the common maps, one series of great circles, the meridians, is mapped as a series of straight lines. It might seem at first sight that our extensible map might be so strained that all great circles on the earth's surface might be represented by straight lines. But, as a matter of fact, this is not so. We might represent the meridians and the great circles through a second diameter of the earth as two sets of straight lines, but then every other great circle would be represented as a curve.

The extension of this to four dimensions gives a fair idea of Einstein's basic conception. In a world free from gravitation we ordinarily conceive of free particles as being permanently at rest or moving uniformly in straight lines. We may imagine a four-dimensional map in which the history of such a particle is recorded as a straight line. If the particle is at rest, the straight line is parallel to the time axis; otherwise it is inclined to it. Now if this map be strained in any manner, the paths of particles are no longer represented as straight lines. Any person who accepts the strained map as a picture of the facts may interpret the bent paths as evidence of a "gravitational field," but this field can be explained right away as due to his particular representation, for the paths can all be made straight.

But our two-dimensional analogy shows that we may conceive of cases where no amount of straining will make all the lines that record the history of free particles simultaneously straight; pure mathematics can show the precise geometrical significance of this, and can write down expressions which may serve as a measure of the deviations that cannot be removed. The necessary calculus we owe to the genius of Riemann and Christoffel.

Einstein now identifies the presence of curvatures that cannot be smoothed out with the presence of matter. This means that the vanishing of certain mathematical expressions indicates the absence of matter. Thus he writes down the laws of the gravitational field in free space. On the other hand, if the expressions do not vanish, they must be equal to quantities characteristic of matter and its motion. These equalities form the expression of his law of gravitation at points where matter exists.

The reader will ask: What are the quantities which enter into these equations? To this only a very insufficient answer can here be given. If, in the four-dimensional map, two neighbouring points be taken, representing what may be called two neighbouring occurrences, the actual distance between them measured in the ordinary geometrical sense has no physical meaning. If the map be strained, it will be altered, and therefore to the relativist it represents something which is not in the external world of events apart from the observer's caprice of measurement. But Einstein assumes that there is a quantity depending on the relation of the points one to the other which is invariant—that is, independent of the particular map of events. Comparing one map with another, thinking of one being strained into the other, the relative positions of the two events are altered as the strain is altered. It is assumed that the strain at any point may be specified by a number of quantities (commonly denoted $g_{rs}$), and the invariable quantity is a function of these and of the relative positions of the points.

It is these quantities $g$ which characterise the

gravitational field and enter into the differential equations which constitute the new law of gravitation.

It is, of course, impossible to convey a precise impression of the mathematical basis of this theory in non-mathematical terms. But the main purpose of this article is to indicate its very general nature. It differs from many theories in that it is not devised to meet newly observed phenomena. It is put together to satisfy a mental craving and an obstinate philosophic questioning. It is essentially pure mathematics. The first impression on the problem being stated is that it is incapable of solution; the second of amazement that it has been carried through; and the third of surprise that it should suggest phenomena capable of experimental investigation. This last aspect and the confirmation of its anticipations will form the subject of the next article. E. CUNNINGHAM.

## *LORD WALSINGHAM, F.R.S.*

LORD WALSINGHAM, whose death from pleurisy took place on December 3, in his seventy-seventh year, was a man very highly esteemed in many circles, and in none more than in those devoted to the study of natural history. As an entomologist he was greatly distinguished, and the work and influence which he brought to bear in promoting the study of insects were widely known, and have borne much good fruit. His work was not of the type associated with the name of Fabre, the famous French observer, but he by no means neglected the study of the living insect, and was keenly interested in every problem on which entomology could help to throw light. He saw also its economic importance, and he had the wisdom to know how greatly its value in every direction depended upon the accurate identification of species, and how this in its turn depended upon good methods of classification and arrangement, and upon an exact and stable system of nomenclature. His own studies, and such influence as he could exert, were, in consequence, largely directed towards the fundamental work of naming and describing species, and improving the means that would lead to their more easy identification.

From an early age Lord Walsingham gave his time freely to a study of the Microlepidoptera, or small moths, and he lost no opportunity to add to his collection of these obscure but very important insects. He maintained his interest in them up to the last, and, a month or so before his death, he was to be seen still working at them in the Natural History Museum, to which his own very large collection, together with a valuable library of entomological works, had been transferred as a gift in the year 1910. He was elected a trustee of the British Museum in 1876, and a fellow of the Royal Society in 1887. As a trustee of the museum, more especially during the time when he was a member of the Standing Committee, he was always actively interested in its affairs, and it was doubtless due to his initiative that the entomological staff was increased, and entomology afterwards made into a separate department. He would like to have seen the staff still further increased, for he was greatly impressed with the necessity of having a large and competent staff to deal with the rapidly accumulating accessions of specimens.

Lord Walsingham was president of the Entomological Society in 1889–90, and in one of his addresses he pointed out that of the more than two million species of insects estimated to be living on the globe, less than a tithe had been named and described, and the vast majority were still altogether unknown. His entomological publications, beginning in the year 1867, were numerous, and always showed careful and accurate work. They appeared in the "Biologia Centrali-Americana," the "Fauna Hawaiensis," in catalogues of the British Museum, and in the transactions and proceedings of the Entomological, Zoological, and Linnean Societies, to each of which he belonged as a fellow; and also in the *Entomologists' Monthly Magazine*, of which he had been one of the co-editors, as well as in other scientific journals. Entomology, however, was not his only interest; ornithology and other branches of natural history shared in his attentions. He was a traveller and a keen sportsman, and in his time was noted as a great shot. He was a graceful and gifted speaker, and as a man of wide knowledge and good judgment was always listened to attentively at the scientific or other meetings in which he used so frequently to take a part. Although he might have made his mark in almost any sphere of life, Science has reason to be gratified that so great a part of his time and work had been devoted to her service.

## *NOTES.*

THE Electricity (Supply) Bill was read a second time in the House of Lords on December 8.

THE council of the Royal Institute of Public Health has appointed Prof. Maurice Nicoll, of the Pasteur Institute, Paris, Harben lecturer for 1920.

WE regret to learn that Prof. A. Werner, professor of chemistry in Zurich University, Nobel prizeman for chemistry in 1913, and foreign member of the Chemical Society, died on November 15 at fifty-two years of age.

SIR RICHARD REDMAYNE, who has been Chief Inspector of Mines since 1908, will shortly resign his post. He proposes to devote himself in the future to the work of the Imperial Mineral Resources Bureau, of which he is the chairman, and to the practice of his profession as a consulting mining engineer.

THE late Dr. John Aitken bequeathed the sum of 1500*l.* to the Royal Society of Edinburgh for the purpose of publishing in book form a collection of his papers read before various societies. He also left to the Universities of Edinburgh and Glasgow any of his dust, colour, or other apparatus which they may wish to possess.

THE Elliot medal for 1918 of the U.S. National Academy of Sciences has been awarded to Mr. C. W. Beebe, of the New York Zoological Society, on the com-

pletion of the first volume of his work on "The Pheasants." The medal is awarded annually to the author of the leading publication of the year in zoology or palæontology. The first award was made for the year 1917 to Mr. F. M. Chapman for his volume, "The Distribution of Bird-life in Columbia," published by the American Museum of Natural History.

A CONFERENCE of representatives of research organisations connected with the Scientific and Industrial Research Department will be held at the Institution of Civil Engineers, Westminster, to-morrow, December 12, at 2.30. Mr. A. J. Balfour, president of the Committee of the Privy Council for Scientific and Industrial Research, will preside, and will deliver an introductory address. A paper on "Research Associations and Consulting Work and the Collection and Indexing of Information" will be read by Mr. H. J. W. Bliss, and one on "The Equipment of Research Laboratories" by Dr. W. Lawrence Balls.

BEFORE the war the Royal Institute of Public Health was accustomed to hold an annual congress, which was attended by well-known leaders engaged in the conduct of measures for the prevention and arrest of disease. In 1912 Berlin was the meeting-place; in the following year Paris welcomed the institute; and the last congress was held in Edinburgh in 1914. These annual meetings of the institute are now to be resumed. The president and council have received a renewed invitation from the Burgomaster of Brussels, M. Adolphe Max, on behalf of the city, and from the rectors of the University of Belgium, for the next congress to be held in Brussels. The dates have been fixed for Thursday, May 20, to Monday, May 24, 1920, inclusive. Delegates will, as usual, be invited from all the universities, municipalities, and other public bodies in due course, and full particulars will be issued at an early date. Meanwhile, all desirous of participating in the congress in the spring of next year should communicate with the Hon. Secretaries, the Royal Institute of Public Health, 37 Russell Square, London, W.C.1.

BY the death of the Rev. E. S. Marshall at Offa's Dyke, near Chepstow, on November 25, the study of British plants has sustained a serious loss. For at least thirty-five years Mr. Marshall spent nearly all his leisure in excursions to almost every part of the British Isles, studying the flora *in situ* and collecting herbarium specimens. He was fortunate in meeting in early days such distinguished botanists as the late Rev. R. P. Murray, and his diligence and accuracy, aided by a retentive memory, eventually placed him in the front rank of field botanists. Mr. Marshall was an authority on Hieracia, and wrote the article on Betula in the second volume of "The Cambridge Flora." For very many years he spent his summer holidays in remote districts in Scotland, his work in this field winning him his recent election as honorary fellow of the Botanical Society of Edinburgh. Owing to the accident of residence Mr. Marshall was particularly conversant with the flora of the south-east of England and of Somerset. In 1899 he collaborated with Mr. F. C. Hanbury in publishing "The Flora of Kent," and in 1914 he wrote a copious Supplement to Murray's "Flora of Somerset," published in the Proceedings of the Somerset Archæological and Natural History Society. He will, however, be chiefly remembered for his almost unique general knowledge of the whole flora of the British Isles, which gave his identifications exceptional authority. Mr. Marshall contributed largely to the *Journal of Botany* and to other botanical works, and revised the tenth edition of the "London Catalogue" in 1908. He was a member of two exchange clubs, and carried on a voluminous correspondence. He bequeathed his fine herbarium to the University of Cambridge.

AFTER serving as secretary of the Royal Horticultural Society for thirty-two years, the Rev. W. Wilks has felt himself compelled by advancing years to resign his office. It is in large measure due to Mr. Wilks's devotion, energy, and ability that the society has been brought to its present flourishing state. When he became secretary the society's finances were at a low ebb and its membership poor; now, thanks to his prudence and enthusiasm—a rare combination of gifts—the society is in a strong financial position, and its membership large and ever increasing. The development of the gardens at Wisley into a research station had his strong support, and, indeed, not the least of Mr. Wilks's titles to enduring memory is the strenuous help which he has given in effecting that *rapprochement* between scientific and practical horticulture which is undoubtedly destined to bring advantage to both. Mr. W. R. Dykes, who has been nominated by the council as Mr. Wilks's successor, is a keen and accomplished gardener, and the author of an admirable monograph on the genus Iris. It is pleasant to know that Mr. Wilks's long official association with the Royal Horticultural Society will continue, and that he will act with Mr. Chittenden, the director of Wisley, as joint author of the society's publications.

UNDER the auspices of the Staff Association, a highly successful scientific reunion—the last of the series for the current year—was held in the board room of the Natural History Museum on November 26, and was attended by nearly eighty members and visitors. The Director, Dr. S. F. Harmer, gave a short address, illustrated by lantern-slides, on "Antarctic Whaling," in which he described the enormous development of the industry in recent years and the methods employed, and discussed the danger of extinction that seems to threaten several of the species of whales, adding that the Government was alive to this danger, and was about to dispatch an expedition to investigate the question. A large number of exhibits were placed round the room. In the Haldane Report on the Machinery of Government it is stated that museums may be considered either as centres for diffusing information or as centres providing facilities for research. That the Natural History Museum fulfils the first of these two functions is familiar knowledge, but probably few even among scientific experts are aware what a great centre of research the museum has become. Visitors to these scientific reunions cannot fail to be impressed with the extreme importance and varied nature of the research carried on by the staff of the museum.

THE *Contemporary Review* for December contains an article by Prof. Eddington on Einstein's theory of space and time, and the *Nineteenth Century* has secured an exposition of the matter from Sir Oliver Lodge. Clearly the former is interested in the theory, and the latter in the result predicted and confirmed by the Eclipse Expedition. Sir Oliver holds it dangerous to base such far-reaching conceptions as that of a "warped" space on a predicted effect which may be accounted for in simpler fashion, new and striking though that effect may be. Prof. Eddington, on the other hand, attacks directly our current confusions in regard to the meaning of space and time. Both writers are forced to confess the difficulty of translating Einstein's theory into simple language, Prof. Eddington affirming that the whole theory is a revolt against the simple language which here, as in

so many regions, implies confused ideas. Apparently we are only at the beginning of a long controversy on the merits and demerits of Einstein's theory. The *Times Educational Supplement* seeks to give some material for its readers to form a judgment upon it; its correspondent, however, devotes the major portion of his exposition to Einstein's earlier theory, and touches only lightly upon the new work.

THE Faraday Society, the Royal Microscopical Society, the Optical Society, and the Photomicrographic Society, in co-operation with the Optical Committee of the British Science Guild, meeting in joint session, will hold a symposium and general discussion on "The Microscope: Its Design, Construction, and Applications," on Wednesday, January 14 next. The meeting will be held in the rooms of the Royal Society, Burlington House, Piccadilly, W.1 (by kind permission of the president and council), and it will extend over two sessions—from 4.30 to 6.30 and from 8 to 10 p.m. During the afternoon preceding the meeting, from 2.30 to 4.30, an exhibition will be held in the library of the Royal Society, which will illustrate recent developments in the science of microscopy and the latest applications of the microscope in all branches of industry. The meeting will be presided over by Sir Robert Hadfield, president of the Faraday Society, who will deliver the opening address. Mr. J. E. Barnard, president of the Royal Microscopical Society, will then give a general survey of the subject, and he will be followed by Sir Herbert Jackson. Prof. F. C. Cheshire will speak on the mechanical design of microscopes, and a paper by Prof. A. E. Conrady on microscopical optics will be presented. Further particulars relating to the discussion may be obtained from Mr. F. S. Spiers, secretary, the Faraday Society, 10 Essex Street, London, W.C.2, or Mr. C. J. Lock, secretary, the Royal Microscopical Society, 20 Hanover Square, London, W.1.

PROF. ANNIBALE RICCÒ, whose death in September last at the age of seventy-five we much regret to see announced, was born at Modena on September 15, 1844. In his early days Prof. Riccò took up engineering. He was present at the Meteorological Congress at Vienna in 1873, when he paid visits to several Austrian and German observatories. In 1877 he was appointed professor of physics at Modena, and shortly afterwards professor of physical technology at the Engineering School at Naples. Prof. Riccò took up astronomical work in 1879, becoming an assistant at Palermo Observatory. His work included observations of sun-spots and prominences, comets, and the planet Jupiter. In 1890 he was appointed director of the Observatory of Catania and Etna, which post he retained until his death. His special subject was solar physics. He undertook regular observations of sun-spots and prominences, and took part in several eclipse expeditions: to Russia in 1887, to Algeria in 1900, to Spain in 1905, and to the Crimea in 1914. On the last occasion he detected a new red band in the coronal spectrum, the principal line of which appeared to conform to a series discovered by Nicholson, having the cube roots of their wave-lengths in arithmetical progression. Work on sidereal astronomy, meteorology, seismology, and geodesy was also carried on under his direction. Prof. Riccò further undertook the laborious task of photographing one of the zones of the Astrographic Catalogue (north declination 54° to 44°). In spite of great financial difficulties, he published the catalogue of the first three hours of right ascension. His published papers are very numerous; a recent one directs attention to the advisability of correlating solar variations with meteorological phenomena, on the lines initiated by Prof. Abbot. Prof. Riccò was elected an associate of the Royal Astronomical Society in 1911, and last July he was chosen as one of the four vice-presidents of the new Union Astronomique Internationale.

IN the October issue of *Man* Dr. J. W. Fewkes describes a remarkable carved wooden object from Santo Domingo, now in the collection of the Missouri Historical Society, St. Louis. It is a rude figure of a man found in a cave in that island. The ancient Antilleans are said to have lived in caves, where they performed their religious ceremonies, and the fact that this relic was discovered in a cave accounts for its good state of preservation. It so closely resembles a specimen in the British Museum, described in the Journal of the Royal Anthropological Institute (vol. xxxvii., 1907), that there is little doubt that it represents a Duko or seat used in some religious rite by the prehistoric people of the island.

THE report of the Superintendent of the Archæological Survey of Burma for 1918–19 contains a discussion on the origin of the Shan alphabet. From this it appears that it is derived from the Tibetan rather than from the Burman or the Talaiqu alphabet, and its transmission is due to the close connection between Tibet and the ancient Shan kingdom of Nanehao. Mr. Duroiselle is now engaged on the systematic collection of materials for the early history of Burma. The epigraphical records cover a wide period, and these are now being interpreted. This is supplemented by evidence, not only from Burman chronicles, but also from Chinese works and accounts of the voyages of Arab, Persian, and Indian travellers. The pioneer in this work was Father Sangermano, but the fresh material now available will form a useful supplement to the information collected by him.

THE Danish *Kommissionen for Havundersögelser* (Copenhagen: C. A. Reitzel, 1918) has published an exhaustive geographical and biological study of Randersfjord, a long inlet on the east coast of Denmark. The volume, which is entitled "Randers Fjords Naturhistorie," is edited by Dr. A. C. Johansen. It contains more than five hundred pages, and has numerous excellent maps and photographs. Among the eleven authors who have contributed to this fine work we note that the editor is responsible for the geology, archæology, and vertebrate zoology, Dr. J. P. Jacobsen for the hydrography, and Dr. C. H. Ostenfeld for a long section on the plants and general features of the vegetation. This section is particularly valuable, as the author has entered into the detailed relationship of the plant-life to its environment, and gives many fine photographic illustrations of different vegetation formations. Among the maps in the volume there is a layer-coloured orographical map of the whole district on a scale of 1 : 200,000.

THE habits and economic relations of the guano birds of Peru form the subject of an able Report (No. 2298) by Mr. Robert E. Coker, issued by the United States National Museum. The hordes of penguins, cormorants, gannets, and pelicans which resort to the islands fringing the coast of Peru for breeding purposes are protected by the Peruvian Government for the sake of the vast quantities of guano they deposit. This, owing to the fact that rain never falls, retains its nitrogen, which would otherwise be converted into ammonia and lost by evaporation. The pages of the report are crowded with interesting observations on the habits of these birds, and it is to be hoped that immediate steps will be taken to protect certain species, which the author

shows are in grave danger of speedy extermination. A diving petrel is one of these, the penguin another. The first-named is killed remorselessly for food, the other for the sake of its oil and feathers. As an example of what may be done by judicious protection, Mr. Coker quotes the case of the south island of the Chinchas, where the birds were left undisturbed for three years. At the end of that time 22,337 tons of guano were collected.

WITH the October issue the *Scottish Journal of Agriculture* completes its second volume. The contents are varied and interesting. The first article, "Problems of Animal-breeding," points out the essential factors and principles involved, and pleads for commercial utility as the real end in view. The second article, on "Aberdeen-Angus Cattle," is presumably the first of a series on "Scottish Pure-bred Livestock." Both serve as reminders that home-grown beef, as well as home-grown wheat, should find a place in any sound agricultural policy. The articles on "Rhizoctonia Disease, or Stem-rot, on Potatoes" and "*Nosema apis* in Hive-bees" are of the kind that bring home to the farmer the realisation of the way in which science can minister to his needs and solve many of the problems that puzzle and perplex him and cause him financial loss. "Agriculture in the Outer Hebrides" affords an interesting glimpse of the state of the industry in this remote and little-known "corner" of the British Isles. It is not altogether without significance to read that although the spraying of potatoes is a firmly established custom in parts of Lewis, yet the next advance recommended is the enclosing of the arable land, thereby bringing about a substantial increase in all crops and rendering proper rotations practicable. Other articles are "Oat-growing Experiments in Scotland," "Composition of Linseed Recovered from Home-grown Flax," "Scottish Farm Labour," "Woodlands and Woodland Industries in Relation to Small Holdings," and short notes on various subjects such as "Leaf-stripe of Barley," "Village Industries," "Agricultural Labour in Other Countries," and that ever-important and intricate problem "Farm Bookkeeping and Cost Accounting."

THE difficulties appertaining to work done in order to ascertain the changes in chemical composition undergone by fruits during ripening and storage are enhanced by the fact that the fruit-juice may, and generally does, vary in composition with the method of extraction. In the *Biochemical Journal* for November Misses D. Haynes and H. M. Judd describe experiments made to ascertain whether the first runnings obtained from pressed apples after freezing are similar in composition to those obtained later. A uniform sample of apple-pulp was divided into two portions, one of which was immediately frozen in liquid air and pressed so soon as it had re-attained the laboratory temperature, whilst the other was left overnight in a freezing mixture and then treated in the same way. The chemical and physical properties of the two juices were almost identical, thus showing that no more chemical action takes place in the prolonged freezing of an ordinary freezing mixture than in liquid air. In another series of experiments the juice was expressed from apple-pulp in several fractions to ascertain whether the tissues after freezing are freely permeable to all those constituents of the cell-sap present in the expressed juice. It was found that the concentration of acids and sugars is the same in the first fraction as in the last, but the viscosity of the latter is greater than that of the former, indicating that the colloidal constituents of the sap are held back by the tissues. The authors find that the large fluctuations in the samples investigated cause the probable error to be very large, and they point out that neglect of sampling errors by previous estimations made by other workers detracts very seriously from the value of the results obtained.

SOME notes on the use of the aeroplane in African exploration by Lieut. L. Walmsley in the *Geographical Journal* for November (vol. liv., No. 5) are valuable in giving the results of experience. Mr. Walmsley points out that "air-pockets" are normally encountered during the daytime in tropical Africa up to a height of about 6000 ft. As a result he had to do his aerial photography in East Africa in the morning and evening, when the light was not very favourable. Above 7000 ft., however, he thinks that operations could be carried out all day long. As regards the location of air-photographs on the map, Mr. Walmsley points out that two adjoining photographs should overlap, showing at least two objects in common. Owing to the absence of definite objects in hundreds of square miles of African landscape, the only satisfactory method is to operate along clearly marked geographical features, such as rivers, mountain ranges, and roads, so that each picture contains part of an easily recognisable feature. Mr. Walmsley made most successful photographic surveys in north-western Portuguese East Africa. He suggests the application of photographic survey to navigable estuaries, such as those of the Rufiji, Rovuma, or Zambezi. The shifting mud-banks can be seen distinctly at a height of 2000 ft.

MR. P. R. BURCHALL gives an "Elementary Survey of the Present Position of Aerial Photogrammetry" in the *British Journal of Photography* for November 28. After giving many details, he concludes by stating that many thoughtless people imagine that aerial photographs are all that is required for map-making, while many surveyors rather disdain them. "Meanwhile, inventors are busy improving aircraft and photogrammetric apparatus, and mathematicians are busy working out and simplifying systems of correction." He prophesies that as soon as the cheapness and accuracy of the aerial photographic method have been demonstrated, it will be speedily recognised and appreciated.

THE principal results obtained by Mr. H. J. Hodsman and Prof. Cobb in their tests of the expansions of refractory materials were described at the meeting of the Society of Glass Technology held at the University of Sheffield on November 10. On first firing, silica refractories are permanently expanded, while fireclay refractories are permanently contracted. On subsequent reheating both expand, and on cooling contract to their dimensions after firing. It is this type of reversible expansion which has been investigated for a number of materials between 15° C. and 1000° C. Kaolin, carborundum, alumina, alundum, and ball-clay expand at rates which are nearly constant throughout this range. Silica expands up to 500° C. at a rate slightly greater than that of kaolin, between 500° C. and 600° C. at a much greater rate, while between 600° C. and 1000° C. there is practically no expansion. At 1000° C. its total expansion is nearly equal to that of kaolin. A mixture of ganister and clay containing 80 per cent. of ganister expands like silica, while fireclay and pot-clay have expansion curves which lie between those of silica and kaolin, nearer to the former than to the latter.

THE *Times Engineering Supplement* for November directs attention to the announcement that advantage is to be taken of the refitting of the White Star liner *Olympia* for mercantile service to equip her for the use of oil-fuel, and gives this fact in evidence of the

growing favour with which oil-fuel is regarded by shipping interests. In view of the great advantages of oil-fuel, it is probable that only the cheapness of coal and the comparatively high price, and at times the uncertainty, of oil-fuel supplies have prevented the more rapid substitution of liquid for solid fuel on shipboard. The diminished output of coal, hampering bunkering regulations, and fears of labour troubles have caused shipping interests to give closer attention to the question of using oil-fuel under the boilers of steamships. One unsatisfactory feature of the situation is that the British shipowner is likely for a considerable time to come to be compelled to rely on foreign sources of supply. Many of the leading dock authorities, such as at Avonmouth, Belfast, Liverpool, etc., are taking steps to augment the facilities available for oil-fuel storage, and shipowners ought soon to be able to obtain supplies at all important home ports.

THE following works are in preparation for appearance in the Drapers' Company Research Memoirs of the Biometric Laboratory Publications (*Cambridge University Press*):—In the Biometric Series: "Mathematical Contributions to the Theory of Evolution," xvii. "On Homotyposis in the Animal Kingdom": A Co-operative Study, and in "Studies in National Deterioration," "The Health of the School-Child in Relation to its Mental Characters," Prof. Karl Pearson. In the Memoir Series of the Eugenics Laboratory Publications, "The Influence of Parental Occupation and Home Conditions on the Physique of the Offspring," Ethel M. Elderton, is also in preparation for publication by the same firm. *Messrs. Longmans and Co.* have in the press "Diagnosing and Curing of Troubles in Electric Machinery," Prof. Miles Walker.

## OUR ASTRONOMICAL COLUMN.

COMETS.—Prof. Crawford and Misses Fairfield and Cummings have deduced the following orbit of Finlay's comet (1919*d*) from observations on November 9, 12, and 15:—

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| $T = 1919$ Oct. 15·52 G.M.T. | $\log q = 0{\cdot}0056$ |
| $\omega = 318°\ 15'$ | $e = 0{\cdot}7146$ |
| $\Omega = 46°\ 55'$ | Period = 6·688 years |
| $i = 3°\ 23'$ | |

*Ephemeris for Greenwich Midnight.*

| | | R.A. | N. Decl. | Log $r$ | Log $\Delta$ |
|---|---|---|---|---|---|
| | | h. m. s. | ° ′ | | |
| Dec. | 9 ... | 1 46 27 | 14 41 | 0·1046 | 9·5768 |
| | 13 ... | 2 2 24 | 16 26 | 0·1155 | 9·6198 |
| | 17 ... | 2 16 27 | 17 53 | 0·1267 | 9·6621 |
| | 21 ... | 2 29 42 | 19 6 | 0·1377 | 9·7025 |
| | 25 ... | 2 41 16 | 20 7 | 0·1486 | 9·7419 |
| | 29 ... | 2 52 45 | 21 0 | 0·1594 | 9·7796 |

It is of interest that three perihelion passages occurred within five days, viz. Finlay on October 15, Brorsen-Metcalf on October 16, and Schaumasse on October 20.

Another long-period comet, de Vico's of 1846, is expected within the next year or two.

WIRELESS TIME SIGNALS.—The *London Gazette* of November 21 gives an interesting list of the stations that now send out these signals. There are three in Europe, thirteen in North and Central America, four in South America, four in Asia and Japan, three in Africa and Mauritius, four in Australia and New Zealand, and three in the Pacific Ocean (Philippines and Honolulu). A ship with an equipment suited to the different systems used should be able to pick up her time in almost any part of the ocean; a comparatively small increase in the number of signal stations would make this absolutely the case. This is a development in navigational facilities that would have seemed incredible a few years ago.

LEEDS ASTRONOMICAL SOCIETY.—Vol. xxvi. of this society's Journal has lately been published under the editorship of Mr. C. T. Whitmell, and contains, as usual, much interesting matter. A paper on Nova Aquilæ by Mr. C. L. Brook may be specially noted. There are also descriptive papers on stellar subjects by the Rev. I. Carr-Gregg and Miss A. Grace Cook, and a very useful note on the limits of vision (1) in detecting an object, and (2) in defining its shape, by Dr. A. S. Percival. The occultation of 7 Aquarii by Venus, 1918 March 2, observed at Lick Observatory, and that of Cape (1900) No. 1524, 1918 April 11, well observed in Australia, were both predicted by Mr. A. Burnet, an energetic member of the society, now at the University Observatory, Oxford. It is noteworthy that he made these predictions while on military service in France.

## THE JUBILEE OF "NATURE."

### FURTHER OFFICIAL MESSAGES.

WE desire to express grateful acknowledgment of the many friendly references made to our jubilee issue by our contemporaries, and of messages of congratulation received from readers and contributors since those published in NATURE of November 13. It is a pleasant duty to print the following messages which have reached us from official representatives of several important scientific societies:—

November 1. ROYAL SOCIETY OF CANADA: *President, Prof. R. F. Ruttan.*—"It affords me great pleasure to offer you the sincere congratulations of the Royal Society of Canada on the completion of NATURE's half-century of service to the English-speaking world. During this period the journal has not only done much to create and maintain popular interest in natural science, it has also been a driving-power in the recent movement in favour of educational reform. We recognise in Canada that its widely quoted articles have been a strong factor in creating that background of public opinion so essential to ensure official support for scientific education and research. Permit me to add my best wishes for its continued success."

November 3. AMERICAN ACADEMY OF ARTS AND SCIENCES.—"The president and secretaries congratulate the Editor of NATURE on the jubilee of this admirable publication. During fifty years NATURE has upheld a high standard and effectively fostered scientific attainment. To-day the study of the mechanism of the universe is recognised by all thinking men as of exceedingly great importance both in peace and in war. The need was never greater that science—a bringer of increased power to humanity—should be guided by high-minded pilots in order that its great possibilities may be directed in beneficent channels. May the helpful and civilising mission of NATURE long continue!"

November 4. CALIFORNIA ACADEMY OF SCIENCES. *Director of Museum, Dr. B. W. Evermann.*—"NATURE is a publication which has long held a large place in the reading and thought of the California Academy of Sciences. We depend upon it more than perhaps upon any other single publication for the scientific news and achievements of the world. The American publication *Science* is, of course, of great interest to us for American scientific news, but its field is rather limited, and in its presentation of valuable contributions to science it scarcely ranks with NATURE. Their

fields, however, are in a sense quite different, and it is perhaps, therefore, not fair to compare them. It is a matter of very great satisfaction to be able to extend sincere congratulations to NATURE on the completion of its fiftieth year of extraordinarily useful service."

November 8. SOCIETÀ REALE DI NAPOLI: Accademia delle Scienze Fisiche e Matematiche: *Secretary, Senator G. De Lorenzo.*—"Although it is somewhat late, I am glad to express, on behalf of the academy, my sincere congratulations on the important scientific work which your esteemed journal has accomplished during its fifty years of existence, and trust it may have a prosperous future before it."

## THE BRITISH ASSOCIATION AT BOURNEMOUTH.

### SECTION K.

#### BOTANY.

OPENING ADDRESS (ABRIDGED) BY SIR DANIEL MORRIS, K.C.M.G., M.A., D.Sc., D.C.L., LL.D., F.L.S., PRESIDENT OF THE SECTION.

IT has been made abundantly clear that in botany, as in other applied sciences, we must rely in future less on chance individual effort and initiative. We must co-operate our efforts and organise them at every stage, bearing in mind that we shall always require the services of the worker in pure science to solve those larger problems of national importance which confront us. We must be armed by science, or we shall be placed at a disadvantage in the great struggle now before us. We are told that it is absolutely necessary for the prosperity and safety of the country that the development of the resources of the Empire and the production of our industries must be on a scale greatly in excess of anything we have hitherto achieved. As an Imperial people it is our duty to develop our resources to the fullest extent. Fortunately, a great change is taking place in the attitude of the Government and the State towards science, and it is noticeable also in the relations of science to industry and commerce. Since we last met we have lost a number of devoted workers in botany. Apart from those who have passed away in what may be called the course of nature, a sad aspect of the losses sustained in the war is the death of so many brave young men for whom it was anticipated that a bright and successful career was open in the domain of science. Their names are inscribed on the Roll of Honour, and we gratefully bear them in memory.

From the point of view of the scientific exploration of the resources of the Empire, it is satisfactory to note that the publications dealing with the floras of tropical and sub-tropical countries have been continued. These, involving, as they do, so much labour and forethought, are of more than passing interest from the fact that they serve to reveal the distribution of plants that may eventually prove of great economic value. A close investigation of tropical plants is necessary, as allied species or varieties of one and the same species sometimes differ appreciably as regards their economic value.

A new branch of botany has lately come into prominence as one of the results of the devotion to Nature-study and the contemplation of the characteristic features of vegetation as we find it distributed over the earth's surface. Ecology is capable of enormously extending the outlook of botany, and it has so largely added to the interest of field work that we may wonder that the phenomenon of vegetation so long displayed before our eyes had not suggested its sociological aspects long ago. Ecology has its society and journal, and bids fair to establish itself fully in the household of botany. It is hoped that it will mitigate some of the admitted drawbacks of purely laboratory work and revive the old natural history spirit of former days.

The remarkable spread of a comparatively new marsh grass (*Spartina Townsendii*) along certain portions of the southern coast deserves careful study. It is supposed to be a hybrid between *S. stricta* and *S. alternifolia*. It is claimed to be pre-eminent among halophytes on account of the extraordinary vigour with which it spreads over mud-flats, and eventually forms meadows to be measured by thousands of acres in Southampton Water and Poole Harbour. It is a question whether it may not develop into a serious menace to navigable waters. On the other hand, it may prove capable of being utilised in suitable localities as a reclaiming agent. Its economic value in providing material for paper-making or as food for cattle may also receive attention.

The critical study of British plants was supposed to be an exhausted field, but with the necessary insight and careful and critical observation there is much work still to be done. Exchange clubs are active, and additions to local floras are continually being made. New species, varieties, and hybrids are published from time to time. As an instance, *Potamogeton upsaliensis*, hitherto only known in Sweden, has recently been found in East Dorset. Hybrid orchids are being keenly studied, and the occurrence of hybrids in this and other classes of plants opens a wide and interesting field of investigation.

A much desired piece of work is a continuance of Starkie Gardner's interesting investigation of the fossil flora of the Bagshot beds so well shown in the Bournemouth and adjoining cliffs. Some of these have proved exceptionally rich in remains of tropical and sub-tropical plants. So far, in regard to these plant remains, we may say with La Place: "What we know is but little; what we do not know is immense."

My distinguished predecessor, whose work has been largely concerned with the systematic and philosophical side of botany, rightly expressed the general desire for a more cordial understanding between botany and its economic applications. "It is certain," he said, "that our outlook must be widely different after the war, and the changed environment must find us ready to respond in the interest of our country and mankind."

With your permission, and acting on a suggestion made to me, I propose to travel a little outside the usual scope of previous addresses and review the many efforts that have been, and are still being, made to promote the interests not only of the homeland, but also of the Empire as a whole. Before the war it was estimated there were about 3,000,000 square miles of British territory within the tropical zone. A portion of this area, including India, was already producing commodities of the estimated value of 230,000,000*l.* sterling. It is, therefore, in the national interest to keep closely in touch with the conditions and prospects of our tropical Possessions in order that we may render them still more capable of supplying the raw material so necessary to the maintenance of our commercial prosperity.

In recent times one of the most important steps taken in this connection was the establishment, on the recommendation of a Royal Commission appointed by Mr. Joseph Chamberlain, of an Imperial Department of Agriculture in the West Indies. The provision for the upkeep of the Department, approved by Parliament, was at the rate of 17,400*l.* per annum.

When fully organised the Department made grants for teaching science at colleges and secondary schools, and for the maintenance of agricultural schools, botanic gardens, and experiment stations. Special attention was devoted to research work in raising new varieties of sugar-canes and other plants, to the investigation of diseases affecting crops, and to the general amelioration of the conditions under which they were grown. At the end of ten years of strenuous effort it was noticeable that, owing to the expansion and improvement of old industries and the introduction of new, the general conditions in the West Indies were greatly improved. This may be illustrated by the fact that the public revenue of the Colonies had increased from 2,546,724*l.* in 1894 to 3,914,434*l.* in 1911, while the total trade during the same period had increased from 16,270,474*l.* to 26,949,086*l.* There was thus an increase of 65 per cent. in the total revenue and of 60·5 per cent. in the total trade. In reviewing the situation in the West Indies, as the result of the activities of the Imperial Department of Agriculture and those associated with it, the late Prime Minister said: "The work of the Department was universally and gratefully acknowledged by the planters to be largely responsible for the improved state of affairs in all branches of agriculture, and he believed—and he spoke with some experience—it would be difficult to find a case in which any analogous experiment made by the Home Government had attained such speedy and satisfactory results."

A gratifying proof of the appreciation of the work of the Imperial Department of Agriculture in the West Indies was the formation of several Departments on similar lines, first at Pusa in India in 1902, and afterwards in all the tropical Colonies in the New and Old World. Further, twenty competent officers trained in the West Indies are now in charge of the Departments of Agriculture in Ceylon, Mauritius, the Federated Malay States, and Fiji, and on the staffs of the Imperial Department of Agriculture in India and the several Colonies in East and West Africa. Another interesting feature of West Indian progress was the wider appreciation of improved methods of cultivation and of the value of science by members of the planting community. For instance, in 1898 the aggregate amount voted by the local legislatures for staffs, laboratories, and botanic and experiment stations was at the rate of 14,000*l.* per annum. Apart from the funds of the Imperial Department of Agriculture, it is probable that, directly or indirectly, the total amount contributed locally for scientific services is now not less than 60,000*l.* per annum.

There can be no doubt that not only in the West Indies, but also in all parts of the Empire, "enlightenment as to the objects, methods, and conditions of scientific research is proceeding at a rapid rate." Perhaps the most interesting feature of the progress made is in connection with the application of the laws of heredity to the improvement of such highly important crops as sugar, wheat, and cotton. The problems associated with these involve both scientific and economic considerations. As regards the scientific side, it is fortunate that with the beginning of the twentieth century came the rediscovery of Mendel's facts and the stimulating energy of the genetic school which has brought us an entirely new point of view in regard to the increased production of field crops.

Great importance is attached to the improvement of the sugar-cane, as the prosperity of many of our Possessions depends upon it. Further, the requirements of this country approach something like 2,000,000 tons per annum. The sugar-cane, although its origin is unknown, has been cultivated in tropical and sub-tropical countries from remote ages. Up to a recent date its propagation was purely vegetative, as it was supposed to have lost the power of producing mature seed.

Sugar-cane seedlings were observed at Barbados in 1858, but it was only in 1888 that Bovell and Harrison were in a position to utilise the discovery and obtain thousands of self-sown seedlings for experimental purposes. Similar seedlings were also available in Java about the same time. As about this period the standard canes in sugar-growing countries were showing signs of being severely attacked by disease, the discovery of seedlings was a fortunate circumstance. In fact, in some cases it may be regarded as having probably saved the industry. In British Guiana it is reported that in the crop of 1918 seedling canes occupied 83 per cent. of the total areas under canes. Similar results have been obtained at Barbados, where Bovell has continued since 1888 in raising canes of great merit.

In India there is probably a larger area under sugar-cane than in any other country. Its production of sugar is more than 2,000,000 tons. The larger proportion of this consists of a low-grade quality known as jaggery or "gur." Palm-sugar is also produced to the extent of 500,000 tons. Speaking generally, the sugar industry in India is not in a satisfactory condition. In spite of the enormous area under cultivation, India is obliged to increase its considerable imports of sugar from Java and other countries. To obviate this, urgent steps are being taken to improve the character of the canes and establish varieties adapted to local conditions and the circumstances of the sugar-growers.

In the considerable literature of sugar-cane breeding in India Barber has brought together a vast amount of information of singular interest and value. In the few years that have elapsed since he has been in charge of the Coimbatore Research Station he has laid the foundation of lines of inquiry that cannot fail to prove of great value in the permanent improvement of the sugar industry in India.

In his presidential address in 1898 Sir William Crookes stated that the prime factor in wheat production was a sufficient supply of nitrogen. As the supply was then showing signs of exhaustion, he warned wheat-growers of the peril awaiting them. Sir R. H. Rew has now shown that, thanks to the chemist, who came to the rescue, there is practically no limit to the resources of nitrogen. During recent years Biffen, by his successful investigations on Mendelian lines at the Plant-Breeding Institute at Cambridge, has shown that the characteristics distinguishing the numerous wheats can be traced, and the building up of a fresh combination of these characters was possible on practical lines. As the losses caused by disease were so serious, sometimes running to millions of quarters annually, Biffen devoted special attention to the possibility of breeding rust-resisting varieties. He found that the power of resisting the attacks of yellow rust, for instance, was an inheritable character. By crossing Gurka, a Russian disease-resisting wheat, with Square Head's Master, one of the most widely cultivated wheats in this country, Biffen eventually produced Little Joss, which, after trials extending over a period of several years, is said to yield four bushels per acre more than any other variety. Further, it possesses distinct disease-resisting qualities.

Another of Biffen's new wheats is Yeoman. This was raised in order to produce what are known as strong wheats. These are in great demand in this country, as they produce a flour which is much superior for baking purposes to the flour of English wheat. In pre-war days Canadian strong wheats commanded in the market 5*s.* more per quarter than

the best English wheat. Yeoman not only possesses the superior quality of Canadian wheat, but combines with it the high-yielding character of certain English wheats.

A well-authenticated report, supplemented with full details, of the value of Yeoman as a field crop was lately published (*Journ. Bd. Agric.*, vol. xxv., 1161). It was cultivated under normal conditions, but without artificial manure, on three fields on a large farm near Wye, Kent. The cropped area was a little more than twenty-seven acres. The total yield was 2072 bushels, or an average of about seventy-seven bushels per acre. One field, previously under beet, comprising three acres two rods and eight poles, yielded 440 bushels, or an average of eighty-six bushels per acre. These results may be compared with thirty-two bushels, the average yield of wheat in this country.

A most desirable improvement in wheat-growing in this country is to obtain a spring wheat combining early maturity with a yield approaching that of winter wheat. The establishment of a National Institute of Agricultural Botany for the further development of plant-breeding and the distribution of pure seed may be regarded as essential to the welfare and safety of the nation.

Wheat-growing is a very important industry in India. It was estimated in 1906–7 that 29,000,000 acres were under cultivation in wheat with a yield of nearly 9,000,000 tons. Of this 90 per cent. was consumed in India. A botanical survey of the Indian wheats was undertaken by the economic botanists at the Imperial Research Institute at Pusa in 1910. In the following years, by the application of modern methods of selection and hybridisation, high-grain qualities were successfully combined with high-yielding power, rust resistance, and stiff straw, so that wheats were produced which gave upwards of forty-one bushels per acre.

Among the best of the new varieties are Pusa 4 and Pusa 12. Owing to an organised system of distribution of seed, it is estimated that the area under Pusa 12 during the last wheat season (1918–19) was about 400,000 acres. The area under Pusa 4 was about 100,000 acres.

The important work carried on at Pusa by Howard and his accomplished wife has followed closely on the methods found so successful at Cambridge. It is interesting to note that in obtaining new kinds by hybridisation between Indian wheats and rust-resisting forms in Northern Europe a difficulty in regard to flowering at different periods was overcome by sending the Indian parents to Cambridge for spring sowing and by carrying out the actual crossing with Biffen's new hybrids in England. From the crosses thus obtained Howard reports that a wide range of wheats has been evolved likely to prove superior to Pusa 4 and Pusa 12.

The admirable work done by Biffen at Cambridge and the Howards in India clearly demonstrates the value of thorough acquaintance with pure botany as a qualification for grappling with questions of economic importance.

In reviewing the gain to Indian wheat-growers the director of the Agricultural Research Institute has recently stated that, in view of the favour with which the new wheats have been received and the cordial co-operation of provincial organisations, "it is a modest estimate to assume that in the course of a very few years the area under Pusa wheats will reach 5,000,000 acres. This means an increase in the near future in the value of the agricultural produce of India, in one crop only, of 75 lakhs of rupees or 5,000,000*l.* sterling." Another crop that has received attention is indigo. In regard to this a new method of growing the seed has been worked out, and the cause of the destructive wilt disease has been traced to the destruction of the fine roots and nodules during the monsoon rains. The remedy in this case is the selection of surface-rooted plants which are now in course of being generally grown.

As in wheat, so in cotton, this country is almost entirely dependent on foreign supplies. The uneasiness caused by the excessive dependence of the great Lancashire cotton industry, with exports of the annual value of more than 100,000,000*l.* sterling, on supplies from abroad, and the occasional shortage, have led to general action being taken to encourage the more extensive growth of cotton within the Empire. Next to the United States, which in some years has supplied seven-tenths of our imports, India comes second, but the East Indian cotton is not well suited to the requirements of the English spinner. Egypt, as the third producing country, supplies cotton of great strength and fineness.

The most valuable of all cottons is that known as Sea Island cotton, owing to its introduction and successful cultivation on the coastal areas in South Carolina, Georgia, and Florida. It is interesting to report that in recent years Sea Island cotton has been introduced back again to the West Indies, which was probably its original home. This was effected by the Imperial Department of Agriculture in the West Indies in 1902, when a pure strain of seed raised from plants immune to wilt disease was obtained in quantity from James Island. This ensured that the industry from the first was placed on a firm basis, and with the hearty co-operation of the planters an important West Indian cotton industry was successfully established. For some years the West Indian cotton has obtained a higher price than the corresponding grades of cotton from the Sea Islands themselves. The fine spinners in Lancashire are now practically independent for their supplies of this cotton from the United States. Further, it is not improbable that, owing to the serious attacks of the Mexican boll weevil on cotton plants in South Carolina and Georgia, the West Indies may become the only source of supply of fine Sea Island cotton. The results so far attained may be realised from the fact that the value of the exports of Sea Island cotton from the West Indies in recent years has reached a total of 2,000,000*l.* sterling. The general conditions in the West Indian islands, owing to their small size and comparative isolation, should enable them to maintain a high purity of cotton. Harland, whose services in the West Indies have been provided by a grant from the Imperial Department of Scientific and Industrial Research, has in hand important investigations with the view of placing the work of cotton selection and breeding on scientific lines. He has shown that the yield of lint per acre depends on a number of factors of a morphological and physiological character. In a general way it may be said that the yield is dependent on the climatic conditions, so an effort is being made to produce varieties which will interact with the environmental conditions to the best advantage. Although Harland's work so far is of a preliminary character, he is able to suggest the conclusion that, following certain lines of selection and breeding, and bearing in mind the relative importance of lint index and lint percentage, it is possible to isolate a strain of Sea Island cotton with a weight of lint per boll 31 per cent. greater than that of the ordinary sorts in cultivation.

As already mentioned, India is the second largest producer of cotton. In 1906–7 it was estimated that there were about 20,000,000 acres under cotton, with a production of nearly 5,000,000 bales. It is unfortunate that the quality of East Indian cotton is

not high, in spite of the considerable efforts made in recent years to improve it.

Leake's research work in the United Provinces, carried on for many years, is regarded as probably the most complete yet attempted with cotton in India. A variety known as K.22 has been widely distributed, and the produce in 1916 sold at 31 rupees per maund when local cotton was 25 rupees. Further, the ginning percentage has been raised from 33 to about 40, while the lint is of superior quality.

Leake has also been successful in raising an early-flowering form of cotton on Mendelian lines. The new form differed from ordinary cotton cultivated in the United Provinces in that it assumed a sympodial instead of a monopodial habit. It not only yielded cotton of high quality, but was found by its early-flowering habit to suit the special conditions of the United Provinces.

As Egyptian cotton comes next to Sea Island cotton in quality, it may be useful to refer to what has been done, or attempted to be done, on scientific lines to safeguard the industry. Its importance may be gathered from the fact that the area under cultivation is between 1,500,000 and 2,000,000 acres. Balls has fully reviewed the scientific and other problems that had to be solved in placing the industry on a satisfactory footing. According to Balls, the high-water mark of Egyptian cotton-growing was from 1895 to 1899. Since that time, although the actual area under cotton has been increased by 600,000 acres, the benefit measured in terms of cotton alone has been small. It is probable that the attacks of the pink boll-worm and other pests may have affected the results, but Balls and his colleagues drew the conclusion that "the falling off in yield was due to a rise in the level of the subsoil water or water-table of the country brought about by the extension of the irrigation system during the past decade." The roots of the cotton plant were thus adversely affected at a critical period of growth. This recalls what Howard discovered: that one of the causes of the wilt disease in indigo in India was the destruction of the fine roots and nodules during heavy monsoon rains.

Probably the most remarkable instance on record of the successful combination of science and enterprise in the tropics is the establishment of a cacao-growing industry in the Colony of the Gold Coast, West Africa. Thirty years ago no cacao of any kind was produced on the coast. Owing, however, to the foresight of the then Governor (Sir William Brandford Griffith), who sought the powerful aid of Kew, cacao-growing was started in a small way among the negro peasantry, with eventually extraordinary results. After selecting the locality for the experiments, seeds and plants were obtained through Kew, and a trained man was placed in charge (*Kew Bull.*, 1891, p. 169; 1895, p. 11). The first exports in 1891 amounted to a value of 4*l.* only. So rapid was the development of the industry that ten years later the exports reached a value of 43,000*l.* By this time both the people and the Government had begun to realise the possibilities of the situation, and systematic steps were taken to organise under scientific control a staff of travelling agricultural instructors to advise and assist the cultivators in dealing with fungoid and insect pests and improving the quality of the produce. In 1911 the exports had increased nearly fourfold and reached a total value of 1,613,000*l.*, while in 1916 what may possibly be regarded as the maximum exports were of the value of 3,847,720*l.*

It should be borne in mind that this Gold Coast cacao industry, now one of the largest in the world, has been called into being and developed entirely by the agency of unskilled negro labour, and on small plots from one to five or ten acres in extent. The controlling factors were, first, the selection of suitable land for cacao-growing; next, the selection and supply of seeds and plants of varieties adapted to local conditions; and, lastly, the advice and assistance of trained Europeans backed by the resources of science.

Coming nearer home, Henry, well known from his association with Elwes in the production of "The Trees of Great Britain and Ireland," by historical research and experiment has established the fact that many fast-growing trees in cultivation, such as the Lucombe Oak, Common Lime, Cricket-bat Willow, Black Italian Poplar, Huntingdon Elm, etc., are natural hybrids. It was of high scientific importance to discover the origin of these valuable trees. Further, by artificial pollination Henry has succeeded in raising new hybrids which display the extraordinary vigour characteristic of the first-generation cross. Perhaps the most notable so far is a new hybrid poplar (*Populus generosa*), which makes the strongest shoots of all poplars. It is claimed in the case of hybrid trees that "it is possible to produce much greater bulk of timber in a given time." The common belief that quickly grown timbers are of inferior quality is said not to hold good in respect of any quality in ash, oak, and walnut. In fact, according to Dawson, "with oak, ash, and walnut the quicker their growth the better their quality in every way. They are more durable, more elastic, and less difficult to work" ("Science and the Nation," p. 138). It is further claimed that by hybridising it may be possible to produce disease-resisting varieties and varieties carrying with them other desirable characteristics.

In the tropics breeding experiments in the case of india-rubber trees are likely to prove of great value. In the meantime, selection of seed from the best trees is being carefully carried out in the hope of increasing the general yield of the plantations. In Java the proportion of alkaloids in the bark of introduced cinchona trees (yielding quinine) has nearly doubled by careful selection on these lines.

Plant-breeding experiments with india-rubber trees have already been attempted, but they are not likely to be of much value if they are confined to empirical and haphazard lines. Work of this kind must be lengthy and complex, but it is absolutely essential to ensure the safety of an industry which is estimated to be of the annual value in the Middle East of about 50,000,000*l.* sterling. The Agricultural Department in Ceylon, which is fully alive to the fundamental importance of the selection and breeding of india-rubber trees, has already taken some action in the matter.

Another investigation in hand is to determine whether the latex-yielding quality of Hevea trees can be associated with any definite botanical characters and to what extent such characters are transmissible. Twenty trees of the same age growing in a four-acre block have been selected for differences in leaf and bark characters. These are all tapped on the same system, and the yield of rubber from each tree is recorded separately for each tapping (*Kew Bulletin*, 1917, p. 118).

The value of these and other experiments of a like nature may be realised when, according to Varnet, quoted by Johnson, the yield of rubber from different trees of Hevea growing under similar conditions in the same plantation may vary as regards volume of latex from 4 to 48, and in percentage of weight of dry rubber from 1·286 to 14·164 (*Journ. d'Agric. Tropicale*, 1907).

Bateson a few years ago expressed the opinion that nowhere is the need for wide views of our problems more evident than in the study of plant diseases. Biffen and others have shown that under certain

conditions the quality inherent in some varieties to resist disease may be utilised to great advantage. The national importance of such work is impressed upon us by the enormous losses sustained every year by rust in wheat, mould in hops, and the widespread disease of potatoes. One of the most striking instances in recent times was the destruction of the valuable coffee plantations in Ceylon. The industry, an exceptionally valuable one, was wiped out in a comparatively few years by the coffee-leaf disease (*Hemileia vastatrix*). In the light of our present knowledge it is not improbable that this disease may have been checked by seed selection or by raising an immune race of plants; or, more probably, as suggested by Armstrong, by regulating the use of essentially nitrogenous manures, which are known in some cases to intensify the attacks of fungoid pests, and substituting the use of phosphates. As illustrating the occurrence of an incidental result arising from a purely scientific investigation, mention may be made of the discovery of a remarkably tall strain of flax at the John Innes Institution. This, if capable of being established on pure lines, may prove of economic value. It is a hopeful sign that the appreciation of the work done at this institution, under the stimulating energy of Bateson, is increasing day by day. We may mention the great success which is attending the establishment of a school of technical education and research by the Royal Horticultural Society at Wisley. This is maintained by liberal funds, and by means of its well-equipped laboratories and extensive trial grounds it offers unique facilities for solving problems of great value as affecting the future of British horticulture. In sympathy with the work at Wisley, private firms are also setting up laboratories of their own and employing men of high standing so that a just balance may be maintained between science and practice. The progress made in the elucidation of problems in tropical plant pathology shows the necessity not only for well-trained and experienced mycologists and entomologists, but also for the correlation and combination of knowledge gained in their several lines of study. It is suggested that research work should be organised on the broadest possible lines, and combine the biological services of the whole Empire. We have a first step in this direction in the Imperial Bureau of Entomology, with its headquarters at the British Museum. Those acquainted with the efficient work done by this bureau and the excellent publications issued by it will very heartily welcome the establishment of the proposed Imperial Bureau of Mycology to carry on work on similar lines.

In this brief review I have endeavoured, however imperfectly, to place on record some of the activities that have taken place in the domain of botany in recent years. It has only been possible to select a few of the most striking incidents where progress has been made. This has been done in the hope of arousing wider interest in work of prime importance as affecting the interests of the home country and the Empire. Botany in its widest aspects affects so largely the welfare of the human race that it is impossible to slacken our efforts. Advance has necessarily been slow, but the creative impulse of science cannot fail to bring in a large harvest of results. This may be possible by encouraging individual efforts, by organising active co-operation, and by associating with us men who are practically grappling with difficulties that seem almost impossible to solve. I have attempted to show in what vast fields of enterprise botanical science has already rendered signal service. As regards the future, if we enlist the best intellects, imbued with the true spirit of progressive research, we shall ensure a continuance of discoveries that have proved so effectual. We must also call to our assistance some of that wonderful energy developed during the war and divert it to the great work before us.

Certainly one of the outstanding features that emerge from a record of botanical research during the last decade or two is the prominent position now occupied by plant-breeding on Mendelian lines. In proof of this we have the numerous well-equipped plant-breeding institutes established and maintained by Government and private funds. Plant-breeding is now in the forefront in relation to the improvement of crops, and the value of it is officially acknowledged as "a vital element in the national policy." According to the Secretary of the Board of Agriculture, what we want "are new races of plants adapted to intensive cultivation," and he adds: "It is my deliberate opinion that an increase in the production of our land is much more easily attainable in that direction than in any other."

## *UNIVERSITY AND EDUCATIONAL INTELLIGENCE.*

CAMBRIDGE.—On Tuesday, December 2, in the hall of Trinity College, a lecture open to the University was given by Prof. Eddington on the theory of relativity. Apart from the interest of the lecture, which attempted—sometimes lightly and sometimes almost dramatically—to present a popular account of the subject, the most striking thing about it was the enormous attendance. Fifteen minutes before the lecture began there was a queue half-way across the Great Court of men anxious to obtain admittance, and during the lecture the hall was entirely filled with dons and students listening breathlessly to hear an intelligible account, if one could be given, of the new theory. The keen interest was due, no doubt, largely to curiosity stimulated by the newspaper accounts of the subject, but also partly to the feeling, to which at last some hope of satisfaction can be given, that a further great unifying principle is needed in natural philosophy. Whatever be the reason, however, the size and appreciation of the audience were no less extraordinary than the subject of the lecture and the brilliance of its exposition.

Mrs. Osborn, the wife of the president of the American Museum of Natural History, has presented a striking portrait of her husband to the Sedgwick Museum. It is proposed to hang this portrait of an old student of Cambridge and an honorary doctor of science of the University amongst the fossil mammals, which have been the subject of his life's work, near the portraits of Darwin and Huxley. The portrait, which is recognised by friends in Cambridge as a remarkably good likeness, is inscribed as follows:—"Henry Fairfield Osborn, LL.D., Sc.D. Camb., a student at Cambridge in 1879, contributor to Comparative Anatomy, Palæontology, Biology, President of the American Museum of Natural History. By Orlando Rouland, New York, 1919."

LIVERPOOL.—The council has appointed Prof. E. R. Dewsnup, professor of railway administration in the University of Illinois, to the chair of commerce, recently endowed by the trustees of the late Mrs. A. W. Chaddock.

MR. A. CONNELL has been appointed to succeed Prof. S. White in the professorship of surgery in the University of Sheffield.

CAPT. L. L. BURCHNALL, scholar of Christ Church, Oxford, has been appointed lecturer in mathematics in the University of Durham.

DR. J. CRUICKSHANK, pathologist to the Crichton Royal Institution, Dumfries, has been appointed

Georgina McRobert lecturer in pathology in the University of Aberdeen.

THE College Board of the London Hospital is offering the Liddle triennial prize (value 120*l.*) for an essay on "The Etiology of Epidemic Influenza." The competing essays must reach the Dean of the London Hospital Medical College on or before June 30 next.

THE New York correspondent of the *Times* announces that by the will of the late Henry Clay Frick all his estate, estimated at 29,000,000*l.*, except 5,000,000*l.*, is bequeathed to public educational and philanthropic objects. The benefactions include the following:—Princeton University, 3,000,000*l.*; Harvard University, 1,000,000*l.*; and Massachusetts Institute of Technology, 1,000,000*l.*

THE council of the Institution of Naval Architects offers for competition a scholarship (value 100*l.* per annum for three years) to be awarded on the results of the Board of Education examinations in naval architecture and other subjects. Candidates must be between eighteen and twenty-one years of age. Full particulars and application forms are obtainable from the Secretary, Institution of Naval Architects, 5 Adelphi Terrace, London, W.C.2. Entries will close on January 15, 1920.

THE annual meeting of the Mathematical Association will be held at the London Day Training College, Southampton Row, London, W.C.1, on January 7 and 8, 1920. The address of the president, Prof. E. T. Whittaker, will be on "Some Mathematical Problems Awaiting Solution"; and the papers to be presented are: "A Survey of the Numerical Methods for Solving Equations," the president; "The Use of Symmetry in the Teaching of Geometry," C. Godfrey; "Convention and Duplexity in Elementary Mathematics," Prof. E. H. Neville; "The Place of Common Logarithms in Mathematical Training," Miss H. M. Cook; and "The Teaching of Mechanics to Beginners," Mr. R. C. Fawdry.

AN interesting departure in commercial scientific education has been inaugurated by the directors of the Anglo-Mexican Petroleum Co., who have invited Mr. C. R. Darling, lecturer in physics at Finsbury Technical College, to deliver a course of ten lectures to the senior staff on the commercial applications of physics. These lectures are intended to form a broad basis of information which will lead to a fuller appreciation of the specialised lectures to be given by experts connected with the firm. A lecture-room has been provided on the company's premises at 16 Finsbury Circus, and has been equipped with facilities for experimental illustrations. This recognition of the value of science in commerce is a hopeful sign of the times, and an educational scheme of this character cannot fail to lead to increased efficiency in the staff of an industrial firm.

A SPECIAL committee of the Anglo-American Society suggested in the programme for the tercentenary celebration of the *Mayflower* and the Pilgrim Fathers (1620–1920) the foundation and endowment of a chair in American history, literature, and institutions. The sum of 20,000*l.* was required for the endowment of this chair, and this has now been provided by Sir George Watson. It is not proposed that the chair should be exclusively attached to one university, but that it shall be used for the general purpose of stimulating interest and study of America in all the British universities. Neither will the chair be held permanently by one scholar of a single nationality. The scheme provides that it shall be held, for a period of one or two years, alternately by an American and a British scholar or public man, thus drawing upon the best intellectual resources of the two countries, and securing a variety of treatment of the subjects dealt with. The committee points out that as a permanent memorial of America's loyal partnership with Great Britain in the war, as well as of the historic ties of kinship which unite the two peoples and of which the *Mayflower* celebration is a reminder, nothing could be more fitting than the establishment of this educational foundation.

## SOCIETIES AND ACADEMIES.

### LONDON.

**Royal Anthropological Institute,** October 14.—Sir Everard im Thurn, president, in the chair.—Lieut. E. W. P. **Chinnery**: "Dengora baiari" is the ceremony of initiation of young men and women of the Binandere tribe, Memba River, British New Guinea. Pigs are killed, and each candidate stands on the pig contributed by his parents and receives a loin-cloth, *gonga*, various ornaments, and instruction in social conduct. Dramatic plays of a special instructional character, *iaveto*, are performed by the village people and visitors. Ancestral ghosts are said to reside during these ceremonies in the posts, *gusi*, of the men's house, *oro*, and in the *jijima*, properties of the *iaveto*. The *gusi* during such time are said to be *kotembo-kotembo*, but their connection with the dead ends with the completion of the ceremony. Some time afterwards the *jijima* are smeared with pig-grease, decorated with feathers, cast into the river, and implored in the names of deceased ancestors to change into crocodiles and devour the enemies of the tribe. After "dengora baiari" follows a period of seclusion in a house known as *wawa*; this condition, *iawa da vitari*, is removed after some months by a purification ceremony known as *tuna*. The candidates then bathe in the river and enter the normal life of the tribe.

**Zoological Society,** November 18.—Prof. E. W. MacBride, vice-president, in the chair.—Major J. S. **Hamilton**: Field-notes on some mammals in the Bahr el Gebel, Southern Sudan.—Prof. J. F. **Gemmill**: (1) The development of the mesenteries in *Urticina crassicornis* (Actinozoa), and (2) the Leptomedusan *Melicertidium octocostatum*.—Rev. A. H. **Cooke**: The radula of the Mitridæ.—Dr. C. F. **Sonntag**: The variations in the digastric muscle of the Rhesus macaque and the common macaque.—E. S. **Russell**: The righting reaction in *Asterina gibbosa*, Penn.—Lt.-Col. S. M. **Copeman**: Experiments on sex determination.—M. **Turner**: The Nematode parasites of a Chapman's zebra.

**Geological Society,** November 19.—Mr. G. W. Lamplugh, president, in the chair.—Prof. J. E. **Marr**: The Pleistocene deposits around Cambridge. This paper deals with the deposits in the immediate vicinity of Cambridge, and contains new records of sections, fossils, and implements. It is pointed out that, owing to alternating periods of erosion and aggradation, relative height above sea-level is not a trustworthy index of antiquity, and modifications of the classification proposed by W. Penning and A. J. Jukes-Browne are indicated.

### CAMBRIDGE.

**Philosophical Society,** November 24.—Prof. **Eddington** and E. T. **Cottingham**: (1) Photographs of a solar prominence taken during the eclipse of 1919 May 29. (2) The theory of relativity and recent eclipse observations.—W. J. **Harrison**: (1) The hydrodynamical theory of the lubrication of a cylindrical bearing under vari-

able load, and of a pivot bearing. (2) The pressure in a viscous liquid moving through a channel with diverging boundaries.

MANCHESTER.

**Literary and Philosophical Society**, November 18.—Prof. F. E. Weiss, deputy chairman, in the chair.—Prof. T. H. **Pear**: The elimination of wasteful effort in industry. Owing to the impossibility of being able to distinguish sharply between physical and mental effort in the investigation of the problems of economising human energy, physiology and psychology must work side by side. While in many industries improvement of the external conditions of work, such as temperature, ventilation, humidity, and illumination, was rapidly proceeding, less had been attempted in the direction of improving the methods of work themselves. Examples of such efforts illustrated the importance of certain fundamental principles. The first was the adjustment, both in total length and in distribution, of rest-pauses. By introducing suitably chosen rest-pauses and by modifying the working attitude of girls who were engaged in folding handkerchiefs, the output increased 300 per cent., while the folders worked only forty-five minutes in each hour, and were less fatigued than before. The second principle was the substitution of habitual movements for constant acts of decision. By rearranging the method of "assembling" a braid machine, so that the parts were not only put together in a more efficient order, but were more easily found by the workman, sixty-six units were assembled by a man in one day instead of eighteen. The third was the elimination of useless movement. By this means the separate actions required to lay a brick had been reduced from 18 to 5; the output increased from 120 per man per hour to 350.

PARIS.

**Academy of Sciences**, November 17.—M. Léon Guignard in the chair.—C. **Moureu** and A. **Lepape**: The stabilisation of acrolein: Preparation of acrolein. A mixture of potassium bisulphate (5 parts) and potassium sulphate (1 part) is recommended as the best catalytic agent for dehydrating glycerol to acrolein, and full details of the best method of carrying out the preparation on the large scale are given.—J. **Carpentier**: An account of the presentation (made on November 10) of colour kinematographs of the Gaumont establishment. Progress in the application of three-colour photography to the kinematograph has been rapid, and it is now practicable to take kinematographic views in colour.—Sir J. J. Thomson was elected a foreign associate in succession to the late M. Dedekind.—G. **Bouligand**: Solutions of the equation $\Delta u = \lambda u$, analytic and limited in an infinite domain, zero on the frontier.—N. E. **Nörlund**: The calculation of finite differences.—H. **Dulac**: Limit cycles.—O. **Mayer**: Ruled surfaces of the fourth order.—P. **Humbert**: The approximate calculation of the elements of critical Jacobians of a high order.—E. **Belot**: The structure of our stellar universe, deduced from the dualist and vortex cosmogony.—G. **Fayet**: Return of Finlay's periodic comet. This is identical with the comet discovered by Sasaki at Kyoto (Japan) on October 25. From data calculated by the author it was again found by M. Schaumasse at Nice on November 9.—M. **Michkovitch**: Observation of Finlay's periodic comet made at the Marseilles Observatory with the 26-cm. Eichens equatorial. The positions of the comet and comparison star are given for November 10. The comet was well defined and of about the ninth magnitude.—M. **Giacobini**: Observations of the Sasaki (Finlay's) comet made at the Paris Observatory. Positions are given for November 12 and 16.—P. **Chofardet**: Observations of Finlay's periodic comet (1919e) made at the Besançon Observatory. Position given for November 13.—A. **Schaumasse**: Observations of Finlay's periodic comet made at the Nice Observatory. Positions given for November 9, 10, 11, 12, and 13.—A. **Baldit**: The effect produced by the electricity of rain on an insulated wire. An insulated wire exposed to rain behaves as a potential equaliser. The disturbances known to occur in electrical systems with aircables during rainstorms arise from the terrestrial electric field.—A. **Chéron**: An apparatus for the simultaneous examination of the same stereoscopic plate by two persons.—A. **Lartigue**: A new form for the formulæ of line spectra. The formula, deduced from the point of view of general mechanics, is

$$\lambda_m = \frac{4 \times 10^8}{N_0}\left(\frac{p}{2}\right)^2\left(\frac{2}{p}+\frac{1}{m}-\frac{1}{m+2p}\right)\text{Angstroms},$$

in which $\lambda$ is the wave-length, $N_0$ the Rydberg universal constant, $p$ a constant, and $m=(q-p)$, differing only slightly from consecutive numbers. For $p=2$, and $m=q-2=1, 2, 3 \ldots 29$, the formula is identical with Balmer's original series for hydrogen.—G. A. **Hemsalech**: The luminous phenomena observed in the neighbourhood of a plate of graphite carried to a high temperature by an electric current.—H. **Ungemach**: A remarkable deposit of chalcostibite in Morocco. This mineral is rare, and has hitherto been found in only three localities, in minute quantities and as small crystals. The deposit at Rar-el-Anz, in Morocco, is extensive, and the crystals are large and well formed. One measured 9×4×1 cm.—R. **Souèges**: The embryogeny of the Polygonaceæ. Development of the embryo in Rumex and Rheum.—MM. P. **Mazé**, **Vila**, and M. **Lemoigne**: The transformation of cyanamide into urea by the micro-organisms of the soil. Of the three organisms chosen one, *B. coli*, has no action upon cyanamide; the others, *B. prodigiosus* and *B. cloacae*, convert the cyanamide completely into urea, traces only of ammonia being found.—H. **Bierry**: Carnivora and the three classes of food. It appears improbable, from both observation and experiment, that carnivora can thrive on a diet deprived of both fats and carbohydrates.—F. **Mesnil** and M. **Caullery**: A normal process of fragmentation, followed by regeneration, in a polychetal Annelid, *Syllis gracilis*.—A. **Krempf**: Development of muscular layers in the larva of an Anthozoa (*Pocillopora cespitosa*) at the primitive stage of tetraradial symmetry.—F. **d'Hérelle**: The *rôle* of the protecting micro-organism in bird-typhus.—C. **Nicolle** and C. **Lebailly**: The evolution of the spirochetæ of recurrent fever in the louse, as followed in a series of sections of these insects.

## BOOKS RECEIVED.

Psychologies. By Sir R. Ross. Pp. 69. (London: J. Murray.) 2s. 6d. net.

La Colloidothérapie: Résultats Cliniques. By Dr. J. Laumonier. Pp. ii+283. (Paris: F. Alcan.) 5.50 francs.

A New Chapter in the Science of Government. By B. Branford. Pp. xlviii+190. (London: Chatto and Windus.) 5s. net.

A Study of Trade Organisations and Combinations in the United Kingdom. By J. Hilton. Pp. 138. (London: Harrison and Sons.) 1s. net.

Altitude and Health. By Prof. F. F. Roget. Pp. xii+186. (London: Constable and Co., Ltd.) 12s. net.

Forest Woods and Trees in Relation to Hygiene. By Prof. A. Henry. Pp. xii+314. (London: Constable and Co., Ltd.) 18s. net.

The Hardwoods of Australia and their Economics. By R. T. Baker. Pp. xvi+522+plates. (Sydney: The Technological Museum.)

Alternating Current Work: An Outline for Students of Wireless Telegraphy. By A. Shore. Pp. ix+163. (London: The Wireless Press, Ltd.) 3s. 6d. net.

Telephony without Wires. By P. R. Coursey. Pp. xix+414. (London: The Wireless Press, Ltd.) 15s. net.

## DIARY OF SOCIETIES.

*THURSDAY*, DECEMBER 11.

ROYAL SOCIETY, at 4.30.—C. F. U. Meek: A Further Study of Chromosome Dimensions.—J. M. H. Campbell, C. G. Douglas, and F. G. Hobson: The Respiratory Exchange of Man During and After Muscular Exercise.—Dr. A. D. Waller: The Energy Output of Dock Labourers during Heavy Work—C. H. Usher: Histological Examination of an Adult Human Albino's Eyeball, with a Note on Mesoblastic Pigmentation in Fœtal Eyes.—J. Gray: The Relation of Spermatozoa to Certain Electrolytes, II.

LINNEAN SOCIETY, at 5.—Prof. W. A. Herdman: Notes on the Abundance of Marine Animals and a Quantitative Survey of their Occurrence.—J. B. Gatenby: The Fertilisation of the Calcareous Sponges.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Charles A. Ballance: The Surgery of the Heart (Bradshaw Lecture).

ROYAL INSTITUTE OF PUBLIC HEALTH, at 5.—Dr. H. H. Thomson: The Diagnosis and Treatment of Tuberculosis in Relation to Public Health.

MATHEMATICAL SOCIETY (at Burlington House), at 5.—Major P. A. MacMahon: Permutations, Lattice Permutations, and the Hypergeometric Series.—L. J. Mordell: The Generating Function of the Series $\Sigma F(u)x^u$, where $F(u)$ is the Number of Uneven Classes of Binary Quadratics of Determinant $-u$.—H. Steinhaus: Fourier Coefficients of Bounded Functions.—D. Priabandrinsky: Steady Fluid Motions with Free Surfaces.

INSTITUTION OF ELECTRICAL ENGINEERS (at the Institution of Civil Engineers), at 6.—Capt. J. M. Scott Maxwell: Scientific Management—A Solution of the "Capital and Labour" Problem.

OIL AND COLOUR CHEMISTS' ASSOCIATION (at 2 Furnival Street, E.C.), at 7.—The Principle of Application of Paint and Varnish, and How it Affects the Works Chemist of the Paint and Varnish Industry.

OPTICAL SOCIETY, at 7.30.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduate Section) (28 Victoria Street), at 8.—Debate: Worm *v.* Bevel Drive.

ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Certain Late Effects of Injuries of the Nervous System.

*FRIDAY*, DECEMBER 12.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.—Conference of Research Organisations (at Institution of Civil Engineers), at 2.30.—Rt. Hon. A. J. Balfour: Introductory Address.—H. J. W. Bliss: Research Associations and Consulting Work and the Collecting and Indexing of Information.—Dr. W. Lawrence Balls: The Equipment of Research Laboratories.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Prof. Eddington and Others: Consideration of the Theory of Relativity.

PHYSICAL SOCIETY OF LONDON, at 5.—Prof. W. M. Coleman: First Steps in the Experimental Analysis of a Galvanic Cell.—J. W. T. Walsh: Radiation from a Perfectly Diffusing Circular Disc.—Dr. N. W. McLachlan: A Comparative Method of Testing Thermionic Valves for Passing No Reverse Current at High Voltages.—Dr. A. O. Rankine: Recording and Reproducing Sounds by Means of Light.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.

MALACOLOGICAL SOCIETY OF LONDON (at the Linnean Society), at 6.—Rev. Dr. A. H. Cooke: An Abnormality of Structure in the Radula of Certain Rhachiglossate Molluscs.—H. Watson: The Affinities of Pryamidula, Acanthinula, and Vallonia.

*MONDAY*, DECEMBER 15.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting) (at Chartered Institute of Patent Agents), at 7.—R. Rankin and Others: Discussion on Some Reflections on Labour.

FARADAY SOCIETY (at the Chemical Society), at 8.—Lieut. W. A. Macfadyen: Electrolytic Iron Deposition.—A. G. Tarrant: The Measurement of Physical Properties at High Temperatures.—J. G. Williams: The Electrolytic Formation of Perchlorate from Chlorate.—Prof. A. W. Porter: The Vapour Pressures of Binary Mixtures.—S. Horiba: Some Relations between the Solubilities of Solutes and their Molecular Volumes.—Dr. E. J. Hartung: (1) An Accurate Method for the Determination of Vapour Pressure; (2) Some Properties of Copper Ferrocyanide.—Prof. E. D. Campbell: The Solution Theory of Steel and the Influence of Changes in Carbide Concentration on the Electrical Resistivity.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—S. Perks: London Town-Planning Schemes in 1666.

ROYAL SOCIETY OF ARTS, at 8.—Dr. J. T. Hewitt: Synthetic Drugs (Cantor Lecture).

SURVEYORS' INSTITUTION, at 8.—Discussion on The Future of the Institution.

ROYAL GEOGRAPHICAL SOCIETY (at the Æolian Hall), at 8.30.—Capt. E. H. Keeling: In Northern Anatolia, 1917.

*TUESDAY*, DECEMBER 16.

ROYAL SOCIETY OF MEDICINE, at 5.—General Meeting of Fellows.

ROYAL STATISTICAL SOCIETY, at 5.15.—J. E. Allen: Some Changes in the Distribution of the National Income during the War.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—A. J. Wilson: The Application of Liquid Fuel to Heavy-Oil Engines.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—Major E. O. Henrici: Precise Levelling.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Technical Meeting), at 7.—N. E. Luboshez: Fancy Lighting in Portraiture.

ILLUMINATING ENGINEERING SOCIETY (at Royal Society of Arts), at 8.—Capt. W. A. Howells: The Art of Camouflage.

*WEDNESDAY*, DECEMBER 17.

SOCIETY OF GLASS TECHNOLOGY (at Institute of Chemistry), at 2.—J. Connolly, Dr. M. W. Travers, and Dr. W. E. S. Turner: The Position of the Glass Industry in America.

ROYAL UNITED SERVICE INSTITUTION, at 3.—Major-Gen. Sir Lewis Jackson: Possibilities of the Next War.

ROYAL SOCIETY OF ARTS, at 4.30.—C. Grunwald: The Present Economic Position of Russia, and Some Aspects of its Future Development.

ROYAL METEOROLOGICAL SOCIETY, at 5.—F. J. W. Whipple: The Laws of Approach to the Geostrophic Wind.—G. M. B. Dobson: Winds and Temperature Gradients in the Stratosphere.—Capt. C. J. P. Cave: Quotations from the Diary of Samuel Pepys on the Weather.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary of State for the Colonies: An Earthquake at Rabaul in May, 1919.—R. R. Lempriere: The Raised Beach at South Hill (Jersey).—Prof. S. J. Shand: A Rift-Valley in Western Persia.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section) (at Institution of Civil Engineers), at 6.—Prof. G. W. O. Howe: High-Frequency Resistance of Wires and Coils.

ROYAL MICROSCOPICAL SOCIETY (at the Northampton Polytechnic Institute), 7.30–10.30.—Conversazione.

*THURSDAY*, DECEMBER 18.

ROYAL SOCIETY OF ARTS, at 4.30.—P. J. Hartog: Some Problems of Indian Education.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—Adjourned Discussion on A Contribution to the Study of Flotation, H. L. Sulman.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—D. M. W. Hutchison and W. J. Wayte: Electricity in Tin Mining.

ARISTOTELIAN SOCIETY (at 22 Albemarle Street), at 8.—Dr. G. E. Moore: External and Internal Relations.

CHEMICAL SOCIETY, at 8.—Prof. J. Walker: War Experiences in the Manufacture of Nitric Acid and the Recovery of Nitrous Fumes.

*FRIDAY*, DECEMBER 19.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—G. W. Burley: Cutting Power of Lathe Turning Tools, Part II.

*SATURDAY*, DECEMBER 20.

PHYSIOLOGICAL SOCIETY (at St. Thomas's Hospital), at 4.30.

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